ARCHITECTURE DEPARTMENT **CHINESE UNIVERSITY OF HONG KONG**

MASTER OF ARCHITECTURE PROGRAMME 2001-2002 DESIGN REPORT

CITY BLACK - BOX

YAU Chun Sang April 2002

TABLE OF CONTENT

01 ACKNOWLEDGEMENT
02 SYNOPSIS
03 RESEARCH
04 SITE STUDY
05 DESIGN INSPIRATION
06 DESIGN DEVELOPMENT
07 FINAL DESIGN
08 SPECIAL STUDY
09 APPENDICES
10 BIBLIOGRAPHY

This thesis cannot be done without the supports and helps from others...my family, my friends and my teachers and my cuarc dept..

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Concept of black-box:

Black-box is a device to record flight data for every commercial plane. It consists of two parts: cockpit voice recorder (CVR) and flight data recorder (FDR). The FDR contained 48 parameters of flight data, and the CVR recorded a little more than 30 minutes of conversation and other audible cockpit noises. If there is an accident, the black-box would be the last survivable evidence to provide information of the cause of the accident, especially if no witness survives and nobody could tell what has happened.

Metaphor:

If a city is a plane, there should also be a black-box to record down its history. History usually only focus on big events and big figures, i.e. the most significant issues. However, a city black-box can serve as a setting to record down the so-called insignificant stories of a city. The concept of a cockpit voice recorder is to record down any audible cockpit noise, even for those insignificant sounds, as every little sound in cockpit may be an important hint to figure out the cause of a big accident.

If we take the perspective that history is not only limited to those significant people, then the stories of ordinary people lives should also be recorded to provide a clearer picture about a place at certain period of time. Along the dimension of time, the stories of people are actually their memories of the past, and their memories of the past are actually the collective memory of the city, and this collective memory unfolded the history of the city.

02 SYNOPSIS

03 RESEARCH

A. Concept of Black Box
B. Architectural Audio Effects
C. Concept of Oral History
D. Recording Studio Design

Its origin

The first mandate to fit flight recorders on certain aircraft was published by the Civil Aeronautics Administration (later the FAA) on August 1st, 1958. A similar rule was issued by the UK Government in 1960. It said that all civilian passenger carrying aircraft over 20,000lbs should carry a crash protected flight recorder. The first improvements came about in 1965, when flight recorders were required to be painted bright yellow or orange, so making them easier to find after a crash. Why are they still called 'Black Box Recorders' then? The name 'Black Box Recorder' actually came from the fact that most electronic equipment on board an airplane is housed in black rectangular boxes of similar size and weight.

03 RESEARCH

A. Concept of Black Box

Its purposes

aircraft black box set has two different recorders. one is called Cockpit Voice Recorder (CVR), which records the flight crew's voices and other sounds in the cockpit; the another is the Flight Data Recorder (FDR), which monitors the plane's altitude, airspeed, heading and other instrument readings.

Black box recorders are there to collect and record data from various sensors in airplanes. From this data investigators can determine how a crash occurred. For example was it a result of an external event, such as wind shear, was it through pilot error, or was an airplane system fault. In the past this invaluable data has been used to improve aircraft design and will continue to play a vital role in contributing to airplane system improvements. FDRs can also be used to predict future failures before they happen. For example, the information collected after a flight might be useful in deciding whether or not to replace an aging engine or not.

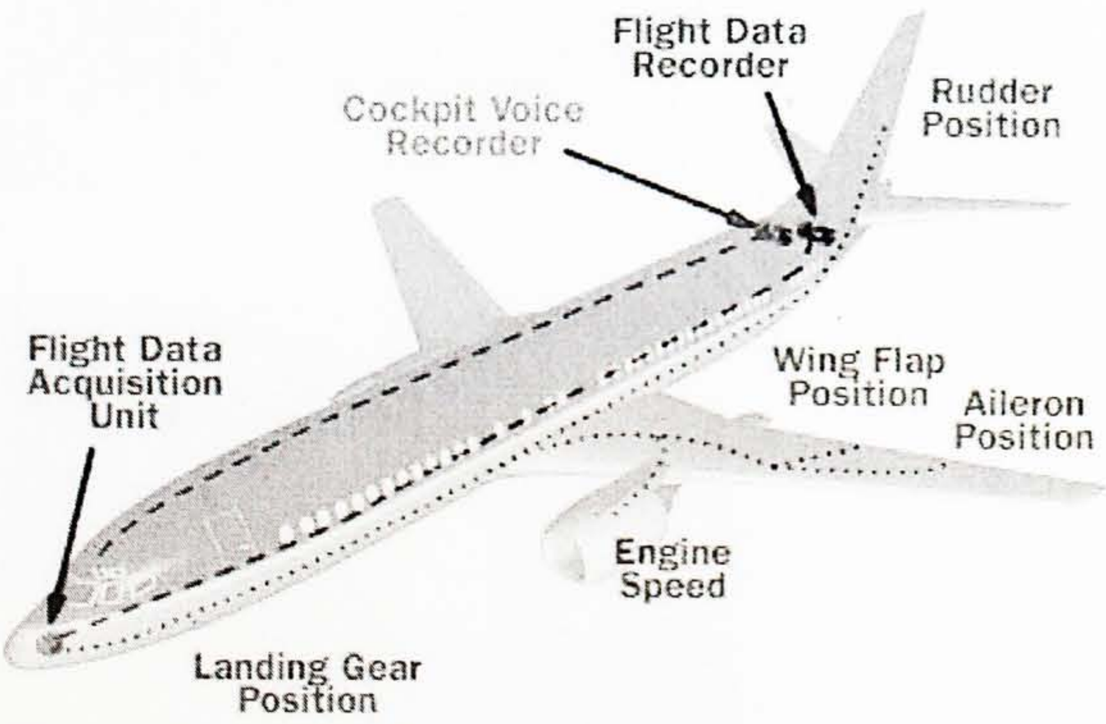
It mechanism

both the CVR and FDR are stored on stacked memory boards inside a Crash-Survivable Memory Unit (CSMU). besides, they are placed in the aircraft's tail because that section usually experiences the least force in a crash.

The crash protected enclosure surrounding an FDR or CVR generally consists of a titanium box lined with heat insulation. The heat insulation must be able to withstand temperatures up to 1100 deg.C for a 30 minute period (this is the temperature at which aviation fuel burns), and also 260 deg. C for 10 hours (simulating a long baggage fire).

The recorder must also be able to withstand a number of shock, vibration, impact, crush, pressure and fluid immersion tests, before it is allowed to go into service.

Underwater locator beacon, which is bolted to the crash-survivable unit, is activated if the recorder is submerged in water. Also known as a pinger, the device can transmit an acoustic signal, with a frequency of 37.5 kHz, from depths as great as 14,000 feet.

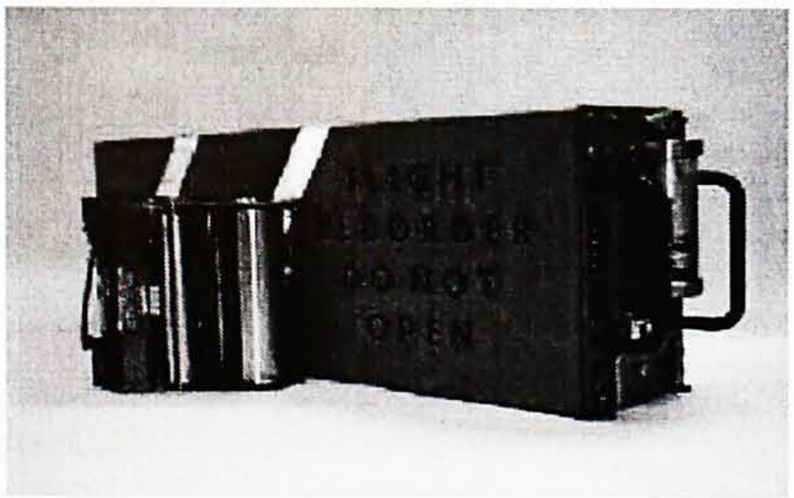


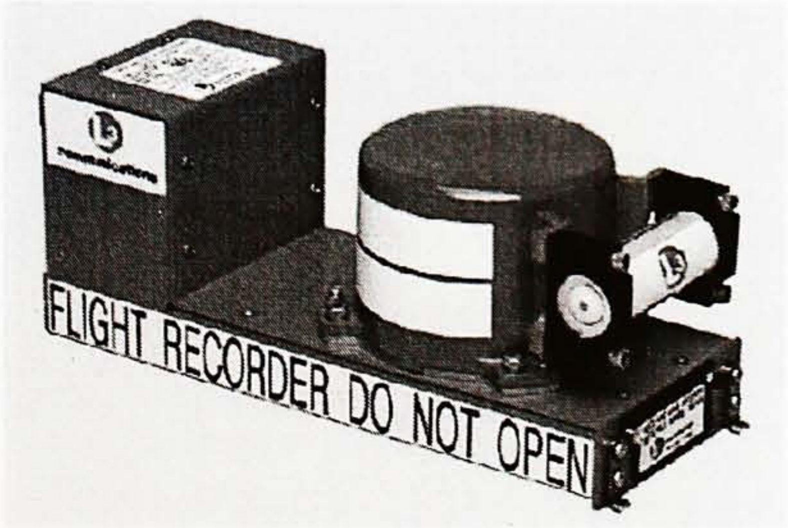
Its technical development

The first generation flight recorders used metal foil as the recording medium (left top). One single strip was capable of recording 200 to 400 hours of data. Scribe arms attached to moving coil meters and air pressure mechanisms literally scratched traces on to the moving foil medium. As the requirements to record more data over the years was increased the second generation of FDRs came about, around the 1970's.

the introduction of Flight Data Acquisition Units (FDAUs) helps process sensor data, then digitizes and formats it so it can be transmitted to the FDR. These second generation digital FDRs, or DFDRs, used magnetic tape 300 to 500 ft long capable of recording 25 hours of data (left middle). Again this was all housed in a crash protection box.

In 1991 another rule change required the installation of digital FDAUs, or DFDAUs, with DFDRs, using solid state memory (left bottom). This system records 34 parameters. They were capable of processing 100 different sensor signals per second for a 25 hour period.





03 RESEARCH

A. Concept of Black Box

Final Words of Flight 261

In the case of Alaska Airlines Flight 261, the conversations between the captain and his first officer pointed NTSB investigators to the plane's stabilizer. This is an excerpt taken from the official NTSB transcript of Flight 261, which crashed on January 31, 2000, off the coast of California. This excerpt contains an exchange between Captain Ted Thompson and First Officer William Tansky and the Los Angeles Route Traffic Control Center (LAX-CTR).

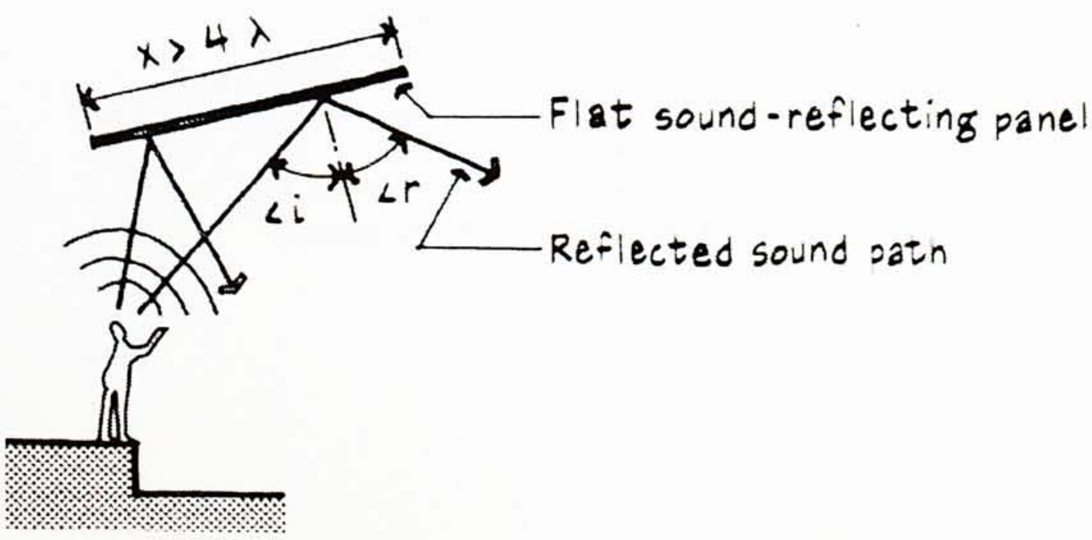
4:09:55 p.m.	**Thompson**: Center, Alaska two-sixty-one. We are, uh, in a dive here, and I've lost control, vertical pitch.
4:10:33	**Thompson**: Yea, we got it back under control here.
4:11:43	**Tansky**: Whatever we did is no good. Don't do that again...
4:11:44	**Thompson**: Yea, no, it went down. It went full nose down.
4:11:48	**Tansky**: Uh, it's a lot worse than it was?
4:11:50	**Thompson**: Yea. Yea. We're in much worse shape now.
4:14:12	**Public address**: Folks, we have had a flight-control problem up front here, we're working on it.
4:15:19	**Flight 261 to LAX-CTR**: L.A., Alaska two-sixty-one. We're with you, we're at twenty-two-five [22,500 feet]. We have a jammed stabilizer and we're maintaining altitude with difficulty...
4:15:36	**LAX-CTR**: Alaska two-sixty-one, L.A center. Roger, um, you're cleared to Los Angeles Airport via present position...
4:17:09	**Flight attendant**: Okay, we had like a big bang back there.
4:17:15	**Thompson**: I think the [stabilizer] trim is broke.
4:19:36	Extremely loud noise
4:19:43	**Tansky**: Mayday
4:19:54	**Thompson**: Okay, we are inverted, and now we gotta get it.
4:20:04	**Thompson**: Push, push, push...push the blue side up. Push...
4:20:14	**Tansky**: I'm pushing.
4:20:16	**Thompson**: Okay, now let's kick rudder. Left rudder, left rudder.
4:20:18	**Tansky**: I can't reach it.
4:20:20	**Thompson**: Okay. Right rudder, right rudder.
4:20:25	**Thompson**: Are we flying? We're flying, we're flying. Tell 'em what we're doing.
4:20:33	**Tansky**: Oh, yeah. Let me get...
4:20:38	**Thompson**: Gotta get it over again. At least upside down we're flying.
4:20:54	**Thompson**: Speedbrakes
4:20:55	**Tansky**: Got it.
4:20:56	**Thompson**: Ah, here we go.
4:20:57	End of recording

Reflection

Reflection (x > 4 ë), Reflection is the return of a sound wave from a surface, If the surface dimension x is larger than about 2 to 4 times the wavelength A of the impinging sound wave, the angle of incidence <i will equal the angle of reflection <r. For example, 1000 Hz corresponds to a wavelength of 1.1 ft; therefore, a surface dimension (length or width) of about 4A = 4 X 1 .1 ~ 4 112 ft will reflect sound energy wavelengths of 1000 Hz and above. When an array of suspended panels is used to direct reflected sound energy toward the audience, the individual panels should be of varying sizes to prevent creating a "rasping" sound Diffusion (x = ë)

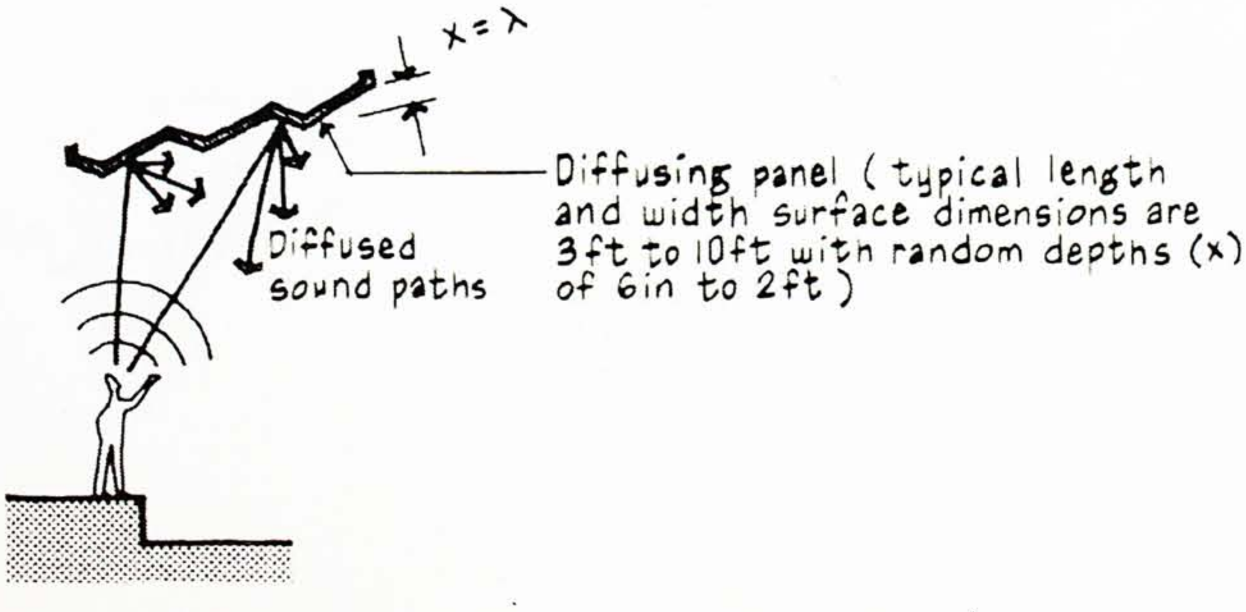
03 RESEARCH

B. ARCHITECTURAL AUDIO EFFECTS



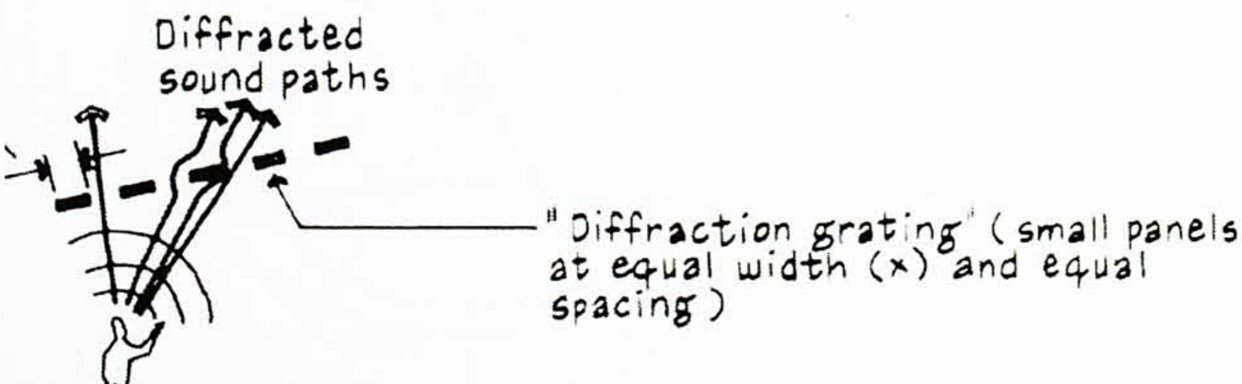
Diffusion

Diffusion is the scattering or random redistribution of a sound wave from a surface, It occurs when the surface depths of hard-surfaced materials are comparable to the wavelengths of the sound, Diffusion does not "break up" or absorb sound-sound is not fragile or brittle! However, the direction of the incident sound wave is changed as it strikes a sound-diffusing material, Diffusion is an extremely important characteristic of rooms used for musical performances, When satisfactory diffusion has been achieved, listeners will have the sensation of sound coming from all directions at equal levels.



Diffraction

Diffraction (x < ë) Diffraction is the bending or "flowing" of a sound wave around an object or through an opening. For example, a truck located behind a building can be heard because the sound waves bend around the corners. In auditoriums, because impinging sound waves will readily diffract around panels that are smaller than their wavelength, suspended panels must be carefully designed to be large enough (length and width) to effectively reflect the desired wavelengths of sound. A single frequency can be emphasized (called diffraction grating effect) when an array of small overhead panels is of equal length and width or vertical projecting slats on walls are of equal depth and spacing. This phenomenon must be avoided because it can impart an odd tonal distortion to music due to cancellation effects.



03 RESEARCH
B. ARCHITECTURAL AUDIO EFFECTS

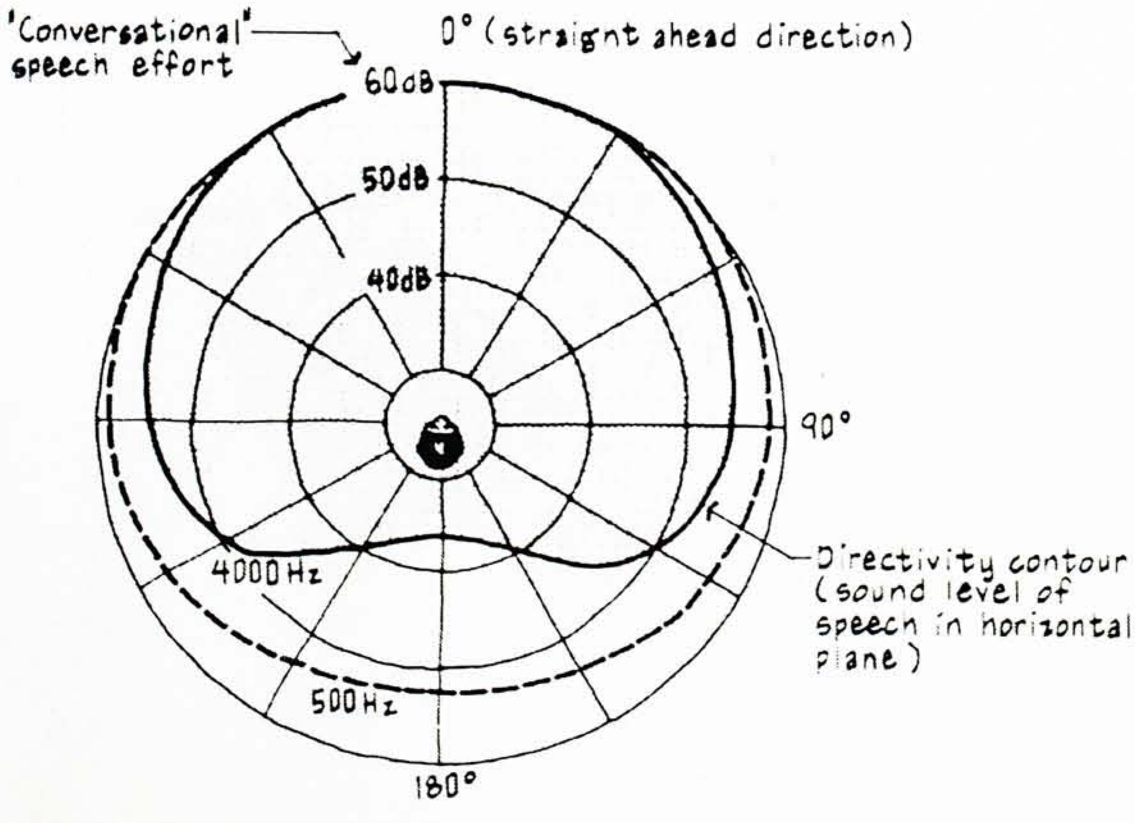
Directivity contours for speech

The higher the frequency of sound, the higher the directional characteristics of sound, and vice versa.

For human speech, low frequencies of less the 500 Hz represent vowels, which contribute to the tone of an individual's speech. High frequencies of more than 4000 Hz represent consonants, which influence intelligibility of sibilants, i.e. 's' or 'sh' sound.

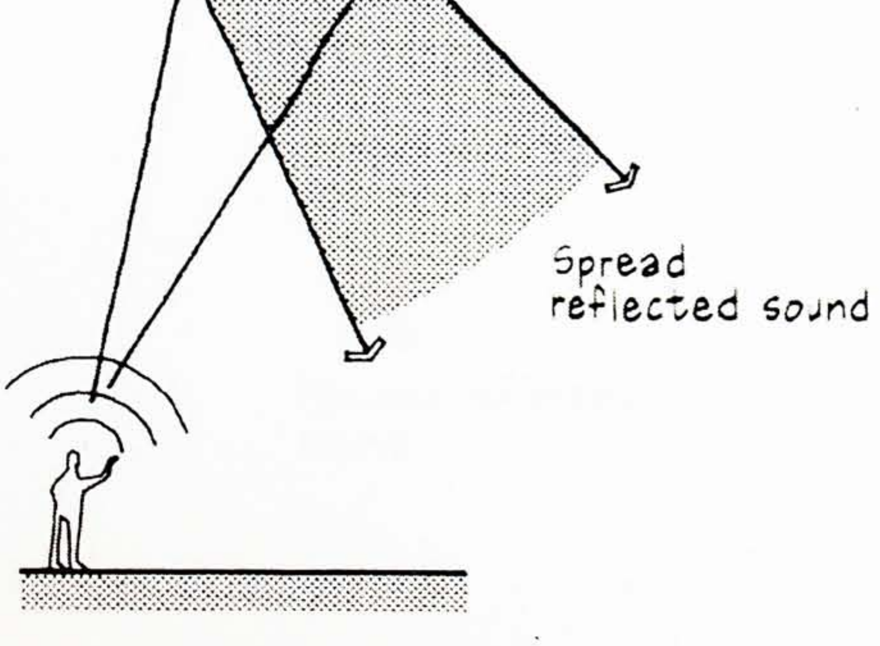
From the polar coordinate graph below, sound levels at low frequencies are diminished very little at the sides and moderately at the rear (8 dB lower). Sound levels at high frequencies are diminished by about 20 dB at the rear. Therefore, when speakers turn their backs to the audience, consonants can become hardly audible.

Speech Contours (500 and 4000 Hz)



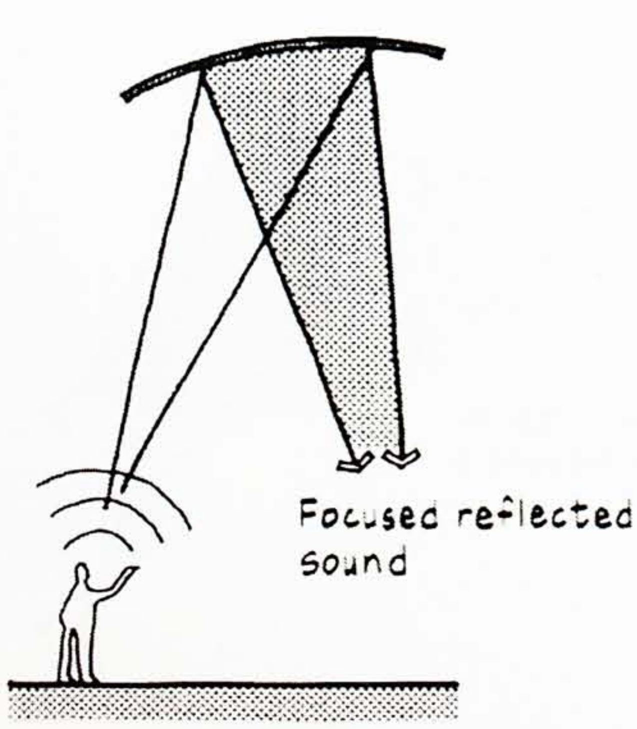
Flat Reflector

Flat, hard-surfaced building elements, if large enough and oriented properly, can effectively distribute reflected sound. The reflector shown below is tilted slightly to project sound energy toward the rear of an auditorium.



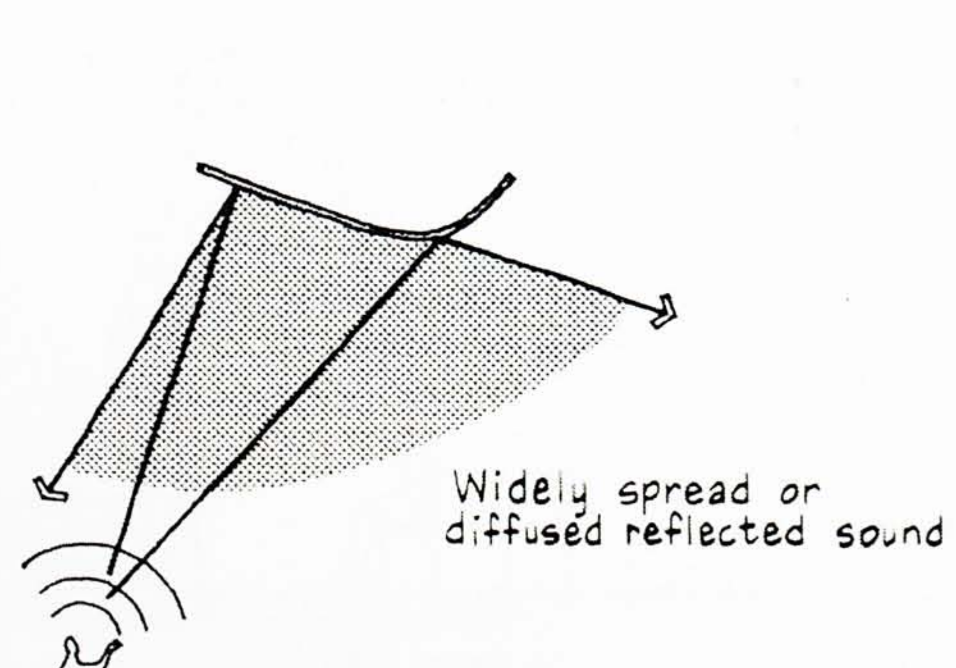
Concave Reflector

Concave sound-reflecting surfaces (such as barrel-vaulted ceilings in churches and curved rear walls in auditoriums) can focus sound, causing hot spots and echoes in the audience seating area. Because concave surfaces focus sound, they also are poor distributors of sound energy and therefore should be avoided where sound-reflecting surfaces are desired (e.g., near stage, lectern, or other source locations in rooms)



Convex Reflector

Convex, hard-surfaced building elements, if large enough, can be most effective as sound-distributing forms. The reflected sound energy from convex surfaces diverges, enhancing diffusion, which is highly desirable for music listening. In addition, reflected sound from convex surfaces is more evenly distributed across a wide range of frequencies.

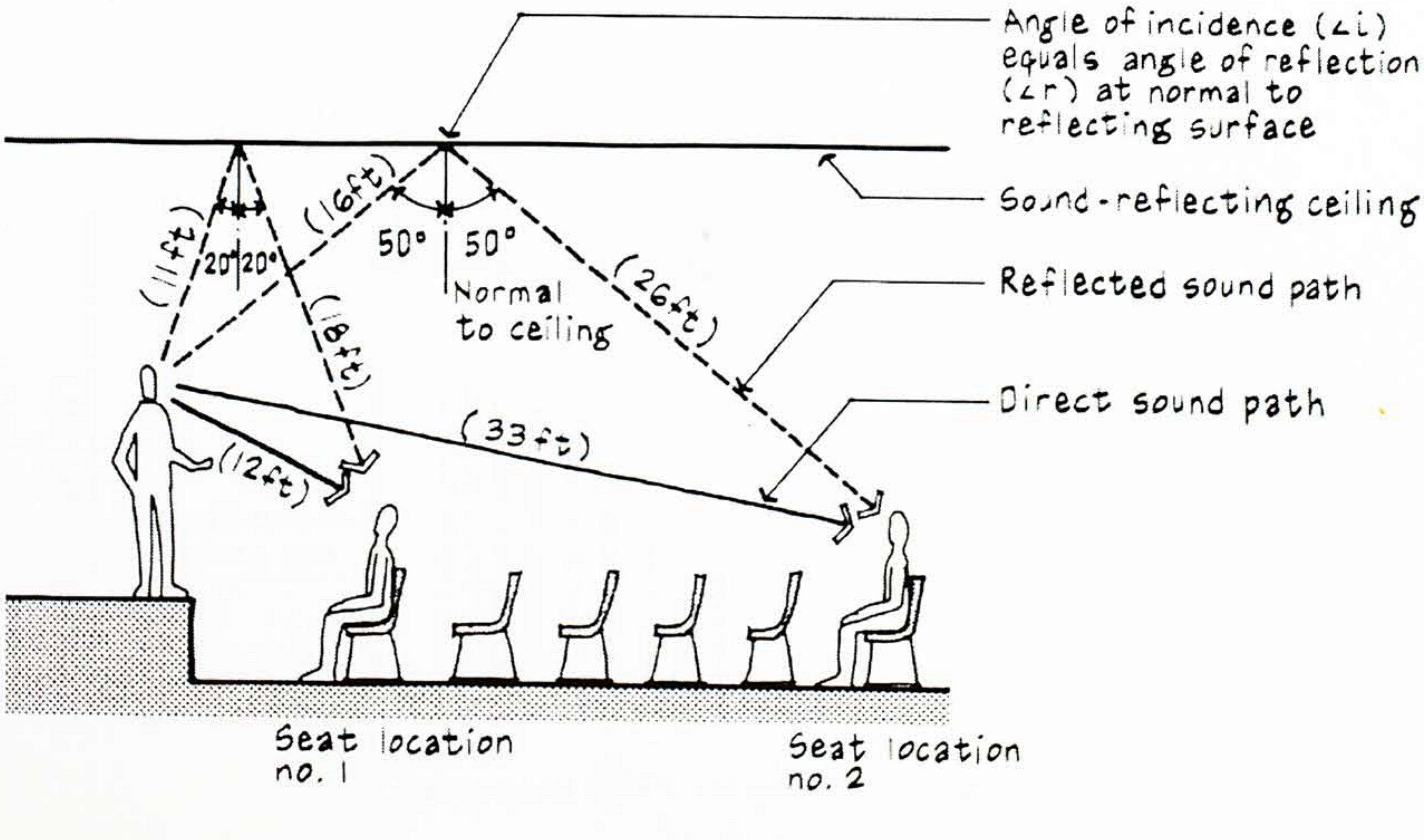


Direct sound path and indirect sound path

Within a building, sound would travels in many paths from the source to the receiver. The one travels from the source directly to the receiver is called 'direct sound path'. And the one reflected by the building surfaces is called 'indirect sound path'.

The longer the sound path difference, the bigger the time delay gap.

03 RESEARCH
B. ARCHITECTURAL AUDIO EFFECTS



Early Sound and Late Sound

The initial-time-delay gap is the time between the arrival of the direct sound and the first reflected sound of sufficient loudnss. It should be less than about 30ms (1ms = 1/1000 second) for good listening conditions because sounds within this time interval can fuse as one impression in a listerner's brain.

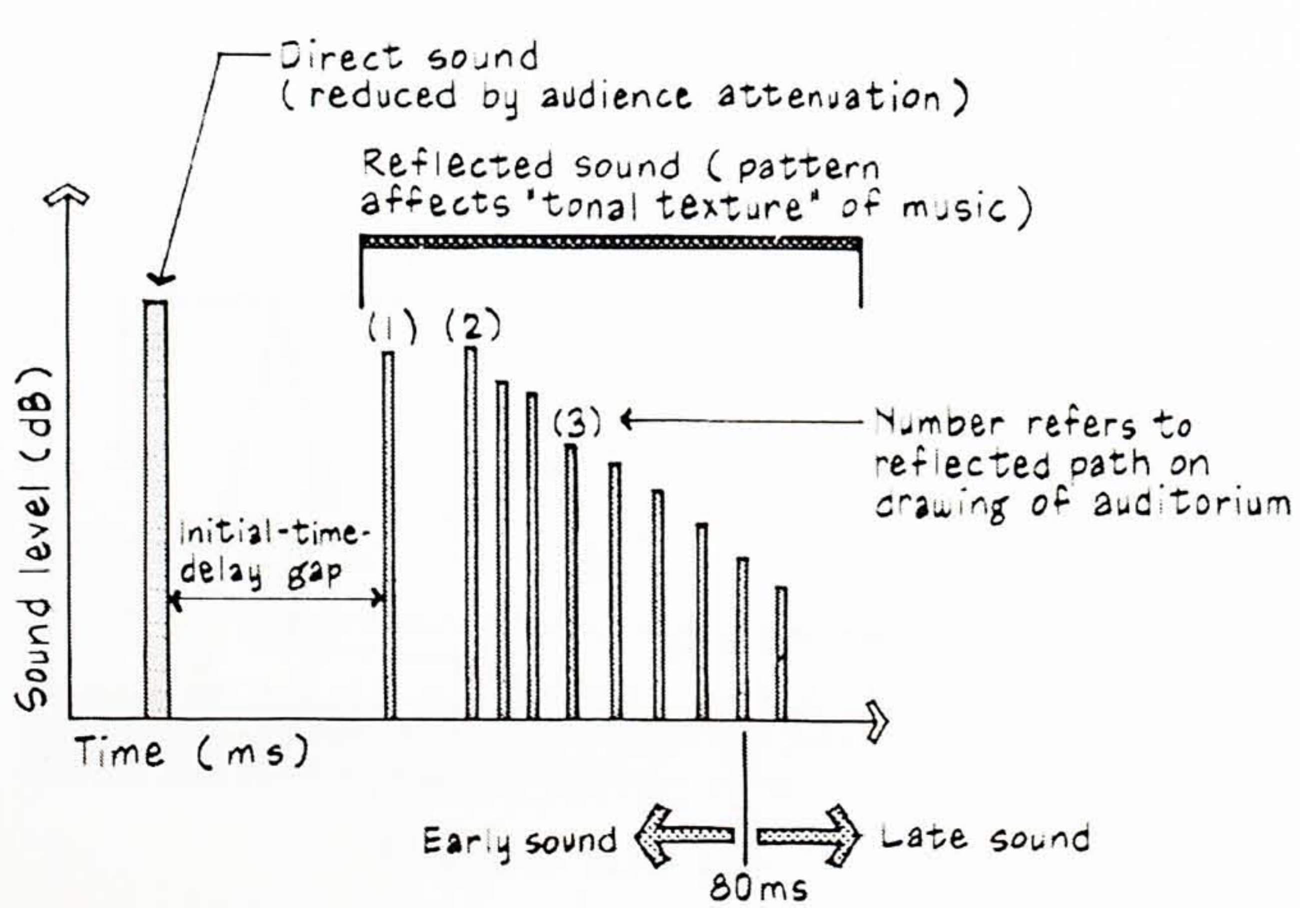
The initial-time-delay gap gives strong influence to a listener's perception of the size of a space (called intimacy).

'Early sound' is defined as the direct and reflected sound arriving within the first 80ms.

Early sound is important for clarity and definition of speech or music.

'Late sound' is defined as the sound arriving later than the first 80ms.

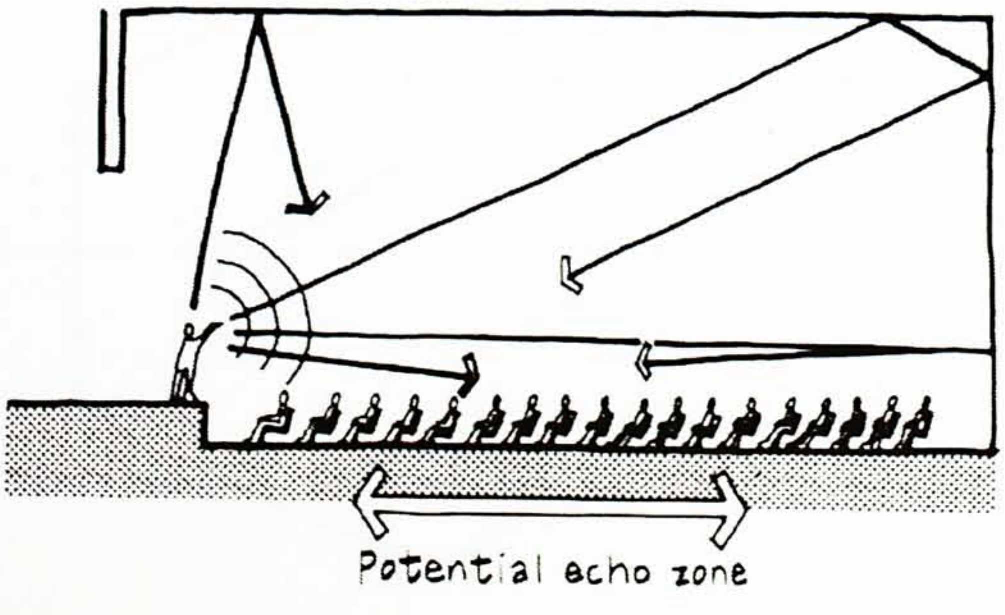
Sound Level vs. Time Graph for Auditorium



Echoes

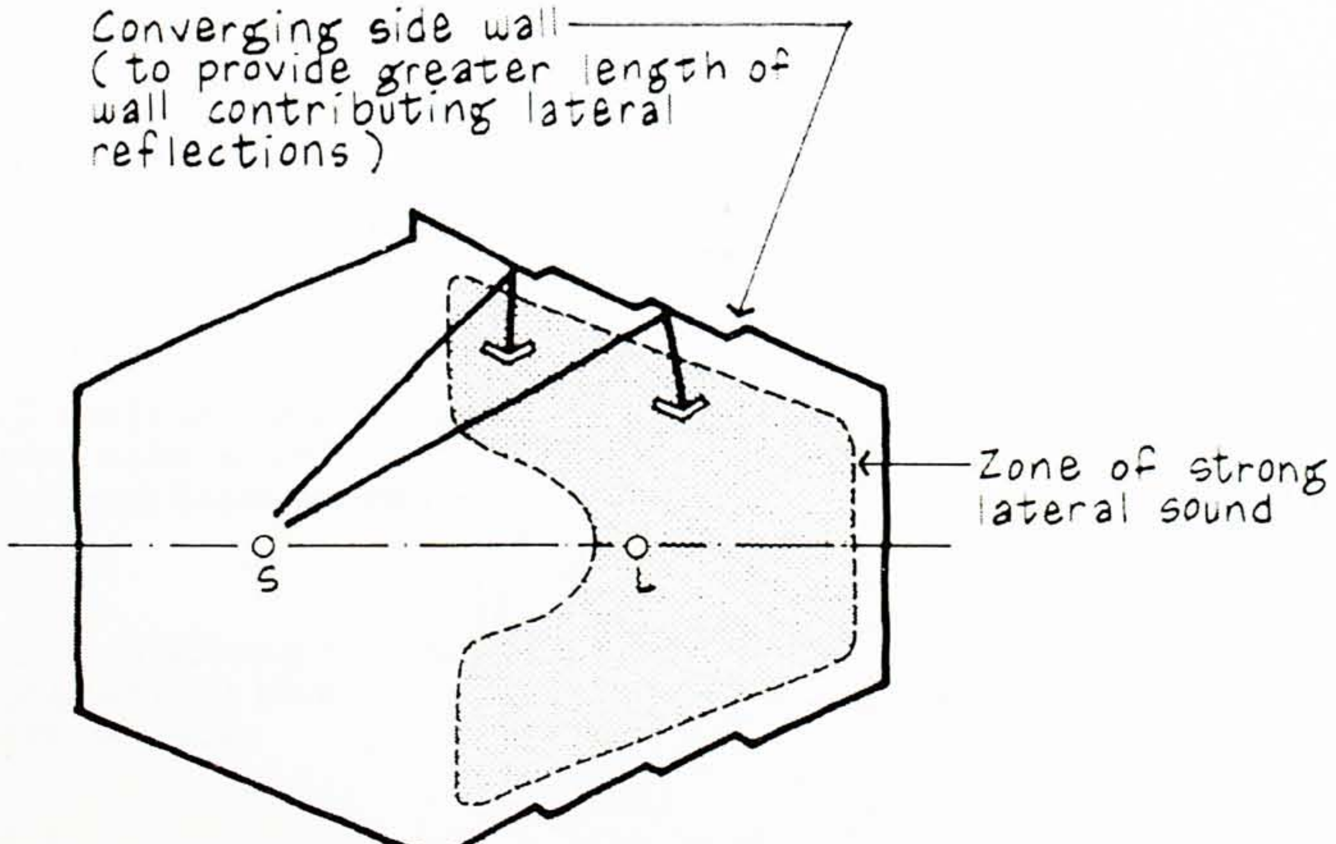
An echo is the distinct repetition of the original sound and is sufficiently loud to be clearly heard above the general reverberation and background noise in a space.

For speech signals, echoes can be perceived when the time intervals between the direct and reflected sounds are greater than 60ms.



Lateral reflections

Sound energy reflected by side walls is called 'lateral reflection'. Lateral reflection help create a favorable auditory spatial impression (or intimacy), which is especially essential for the satisfactory perception of music performances.



Articulation Index

The articulation index (AI) is a subjective measure of speech intelligibility. It can be calculated from the scores of a group of experienced listeners with normal hearing.

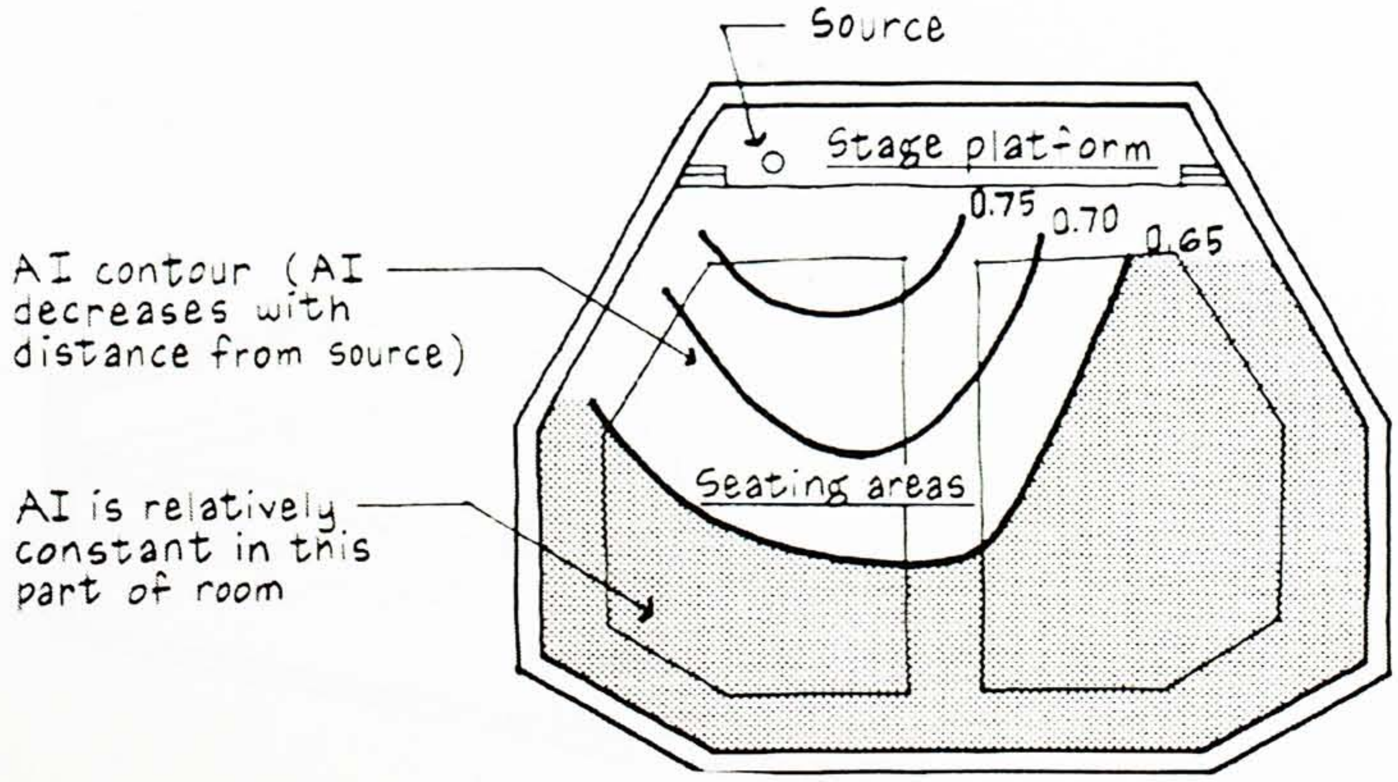
AI of 0.70~1.00 indicates very good condition for communication. AI of 0.40 ~0.70 indicates good condition and AI of 0.00~0.40 indicates poor to fair condition.

High AI can achieve high communication requirements while low AI can achieve high speech privacy.

AI contour can be established to assess the speech intelligibility of a space. AI drops off with distance from the source. Reshaping of the ceiling and control of echoes off the rear wall could raise the AI at the remote locations.

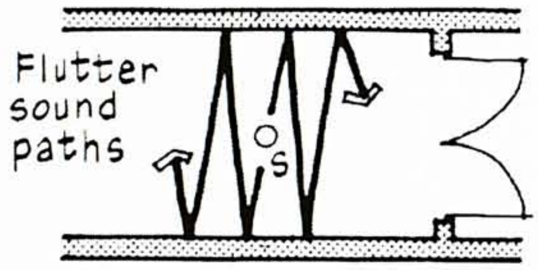
An objective evaluation test method, called the rapid speech transmission index (RASTI), has been developed to electronically measure speech intelligibility in rooms.

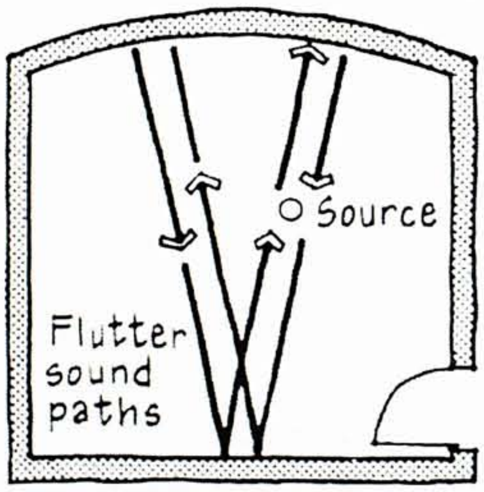
03 RESEARCH
B. ARCHITECTURAL AUDIO EFFECTS

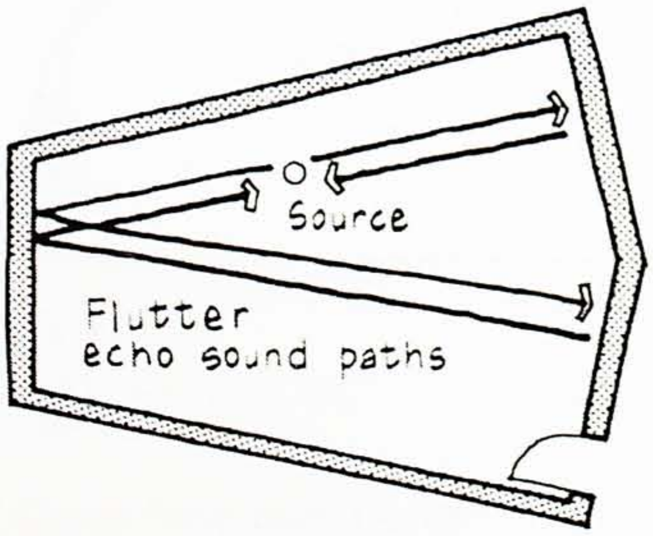


Flutter echoes

flutter echo is usually caused by the repetitive inter-reflection of sound energy between opposing parallel or concave sound-reflecting surfaces.



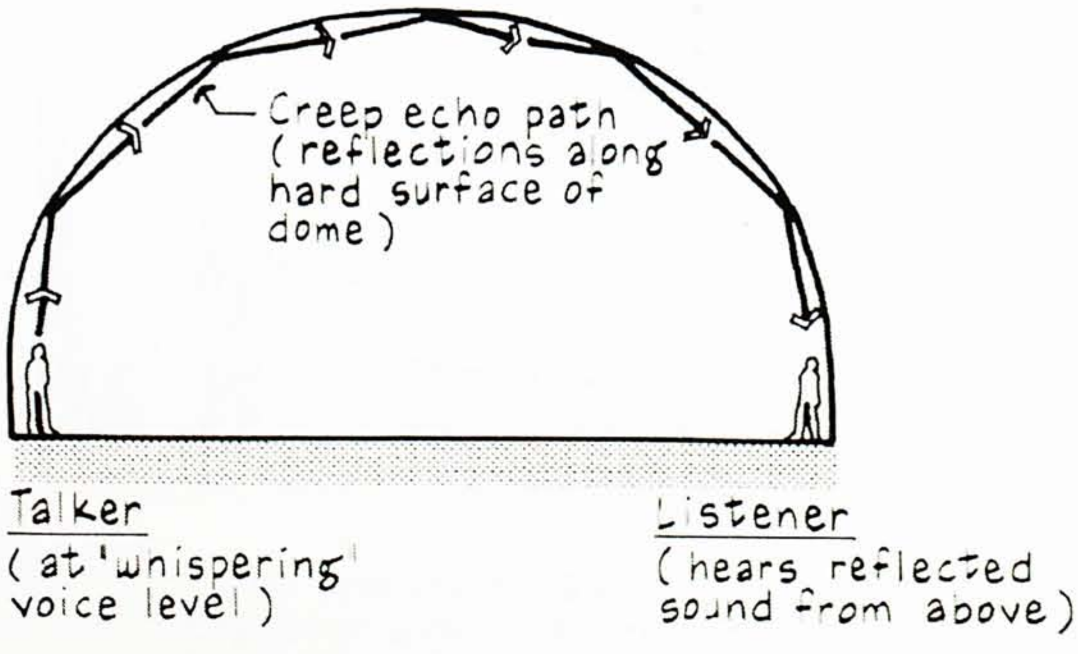




Creep echo

Creep echo, also known as whispering gallery effect, occurs when sound energy is reflected along smooth concave surfaces. Even low voice levels can be heard at considerable distances away.

An example of the whispering gallery effect occurs in the Union terminal Building, Cincinati, Ohio. Sound energy is reflected along the domed ceiling surface allowing persons at opposite ends of the rotunda (>180ft apart) to easily converse at whisper voice levels while persons only a few feet away from the speakers cannot hear the conversation.

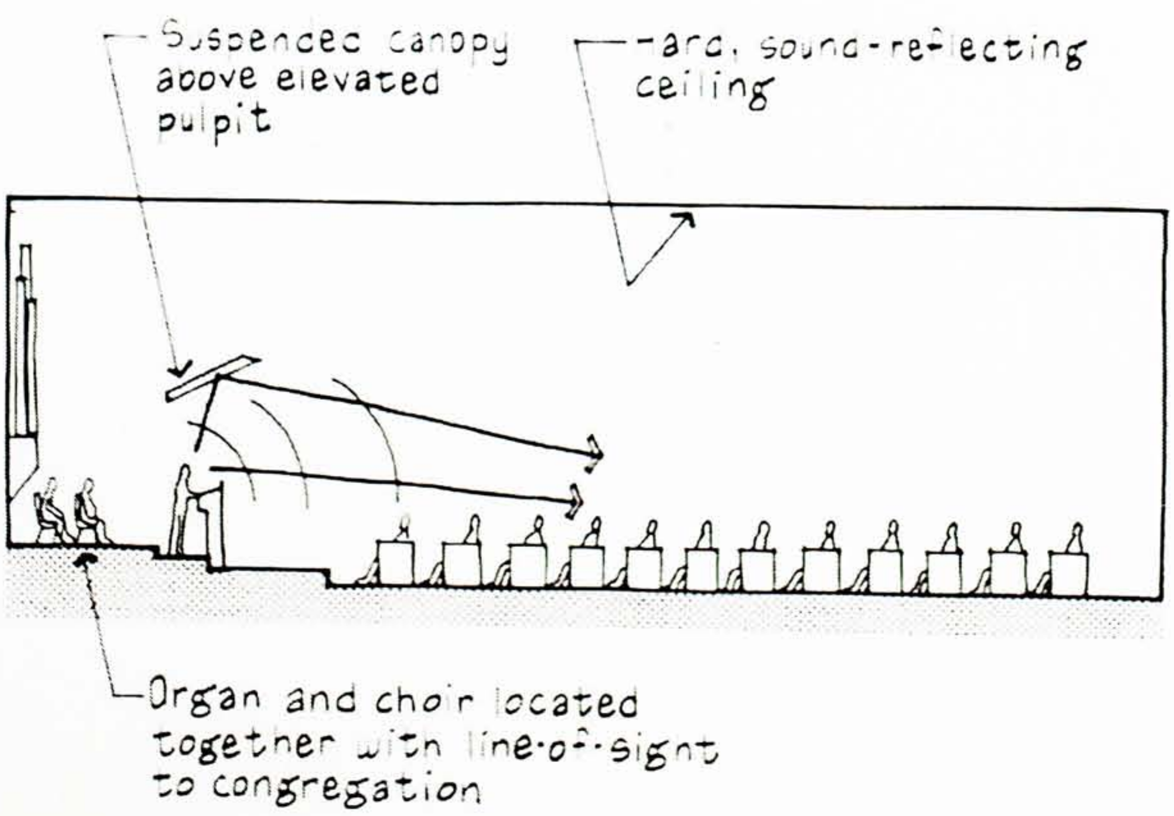


Creep Echo from Dome

Sound Reflectors

An effective sound reflector has a hard surface, such as thick plaster, double-layered gypsum board, sealed wood, or acrylic plastic, and is significantly larger than the wavelength of sound it is designed to reflect. For example, at a frequency of 500 Hz, the wavelength of sound is about 2 h. Consequently, an 8-h-diameter panel (i.e., dimension about 4 times the wavelength) should be used to reflect sound energy greater than 500 Hz. However, sound energy less than 500 Hz can bend around the panel, enhancing reverberation at low frequencies. The sound-reflecting pulpit canopy shown below can provide useful reinforcement of the direct sound as well as prevent long-delayed reflections and potential echo conditions from the high ceiling.

Section View of Church



Concept of Oral History

Oral history is treated as a kind of first-hand accounts and personal perspectives on historical events.

different people have different feelings towards the same event. oral history is a kind of personal memory towards historical events. it implies subjectivity of the recalling process.

oral history can tell us more about how people thought at certain period instead of how we think the way they thought.

oral history has its limitation that it can not trace back to period of time for too long ago. the time range is limited to the availabiltiy of witnesses.

There are many oral history projects held by different universities or library throughout the world. but there is not any such kind of formal project in hong kong.

there are library, university or even specific center for recording regional oral history in many countries. there are also archives available on the internet.

Design requirments for speech space:

When rooms are used primarily for speech, the design goal should be high intelligibility of spoken words throughout the room. To achieve high signal-to-noise ratios (> 15 dB), rooms should be shaped to direct sound from the speaker's location toward the audience, designed to avoid echoes and' 'hot', (or' 'bright' ,) spots, and planned to have low background noise levels. Important acoustical parameters affecting the perception of speech in lecture rooms are summarize by the list below.

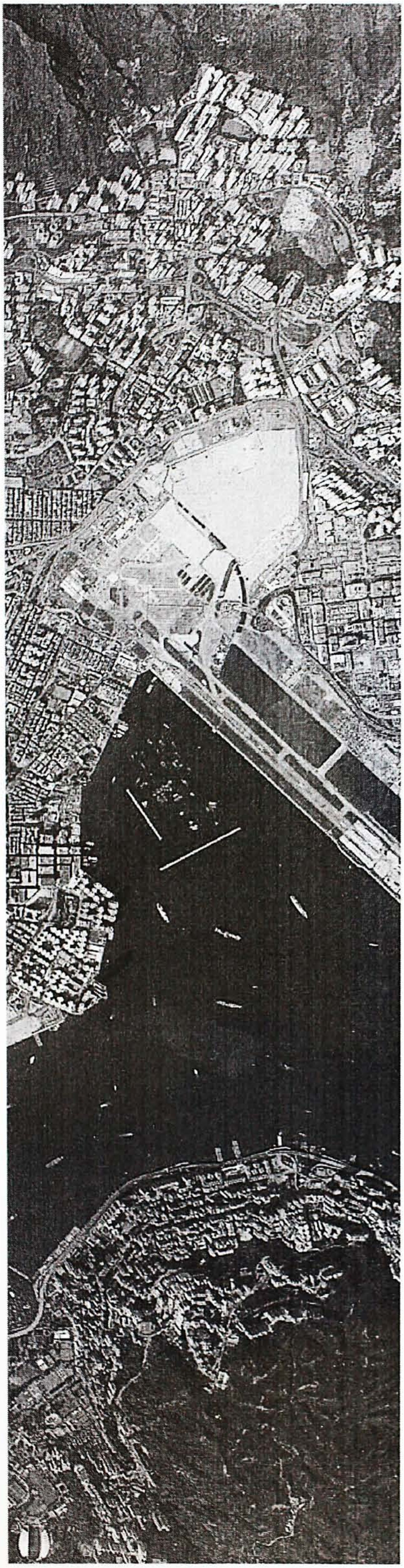
1. To help achieve satisfactory loudness, provide compact room shape with relatively low room volume. Volume per seat ratio should be 80 to 150 ft3 per person.

2. Reverberation times should be less than 1.2 s from 250 to 4000 Hz for theaters and less than 0.8 s for classrooms. Long reverberation times reduce the intelligibility of speech the same way noise masks speech signals. Select sound-absorbing finishes so absorption will be constant within the frequency range for speech. It is preferable to place absorption on sidewalls rather than on ceilings. In small rooms, use sound-absorbing panels with air-space behind to prevent "boominess" at low frequencies.

3. Ceiling or overhead sound-reflecting surfaces should provide short-delayed sound reflections directly to the audience (i.e., path differences between direct and reflected sound should be less than 34 ft.).

4. Background noise levels from the mechanical system should not exceed 34dBA or noise criterion NC-25. Enclosing constructions should reduce intruding noise to below this preferred criterion to avoid interference with desired sounds and prevent distractions. Even lower limits should be considered where rooms are to be used by young children, older adults, or hearing-impaired persons.

5. Smaller lecture rooms, courtrooms, conference rooms, and the like may also require a sound-reinforcing system to assist weak-voiced speakers and to project recorded material evenly. (Be careful because electronically reproduced sound may sound "harsh" and unnatural when played in rooms.)



04 SITE STUDY
Kowloon City

A. General Aspects
B. Historical Context
C.Future Development
D. Sound Level Study
E. Site Condition at Night

04 SITE STUDY

A. General Aspects

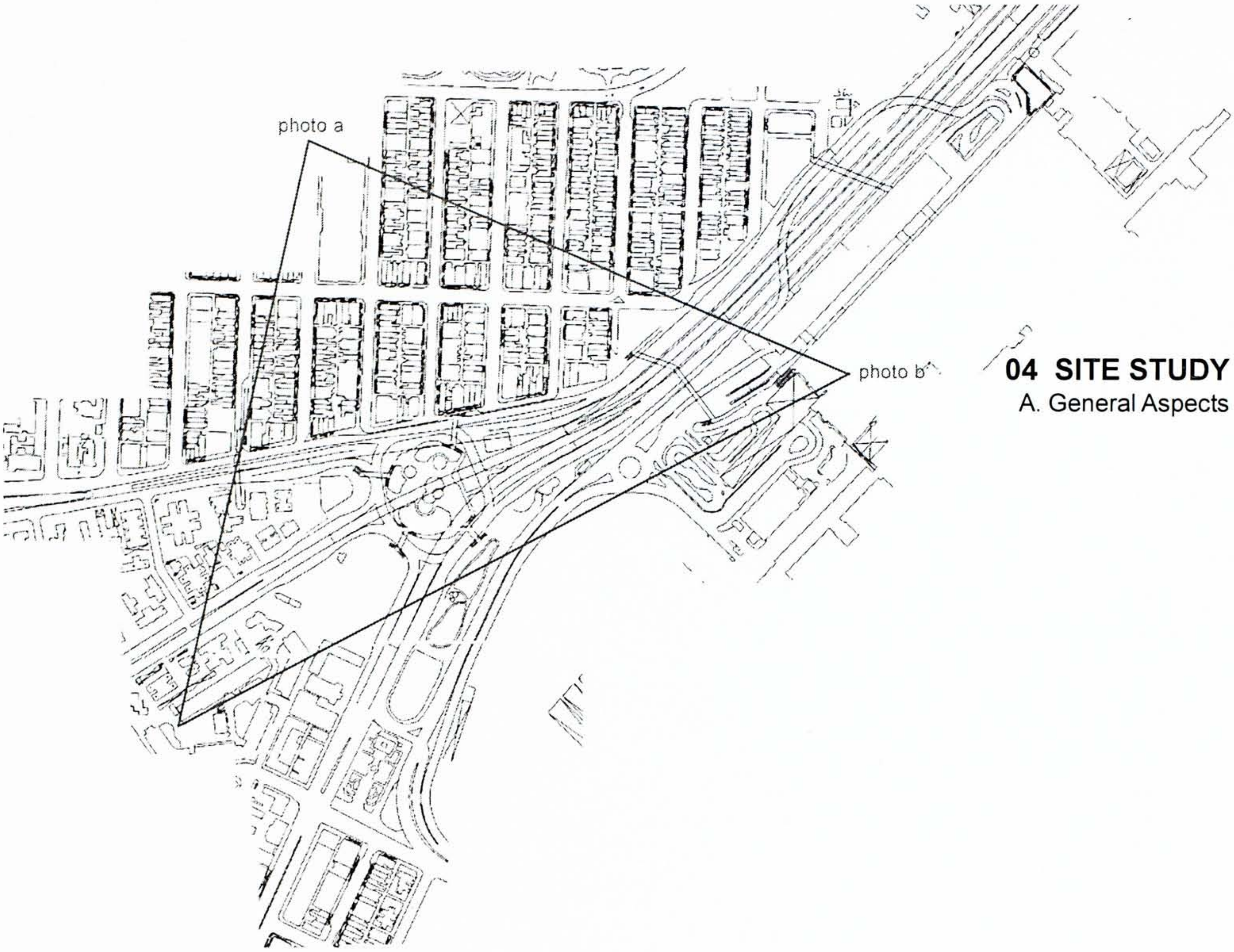
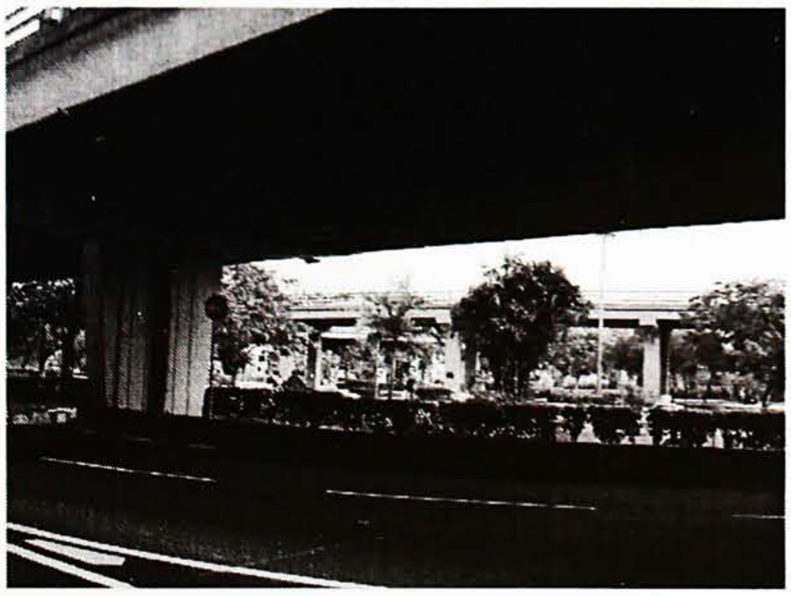
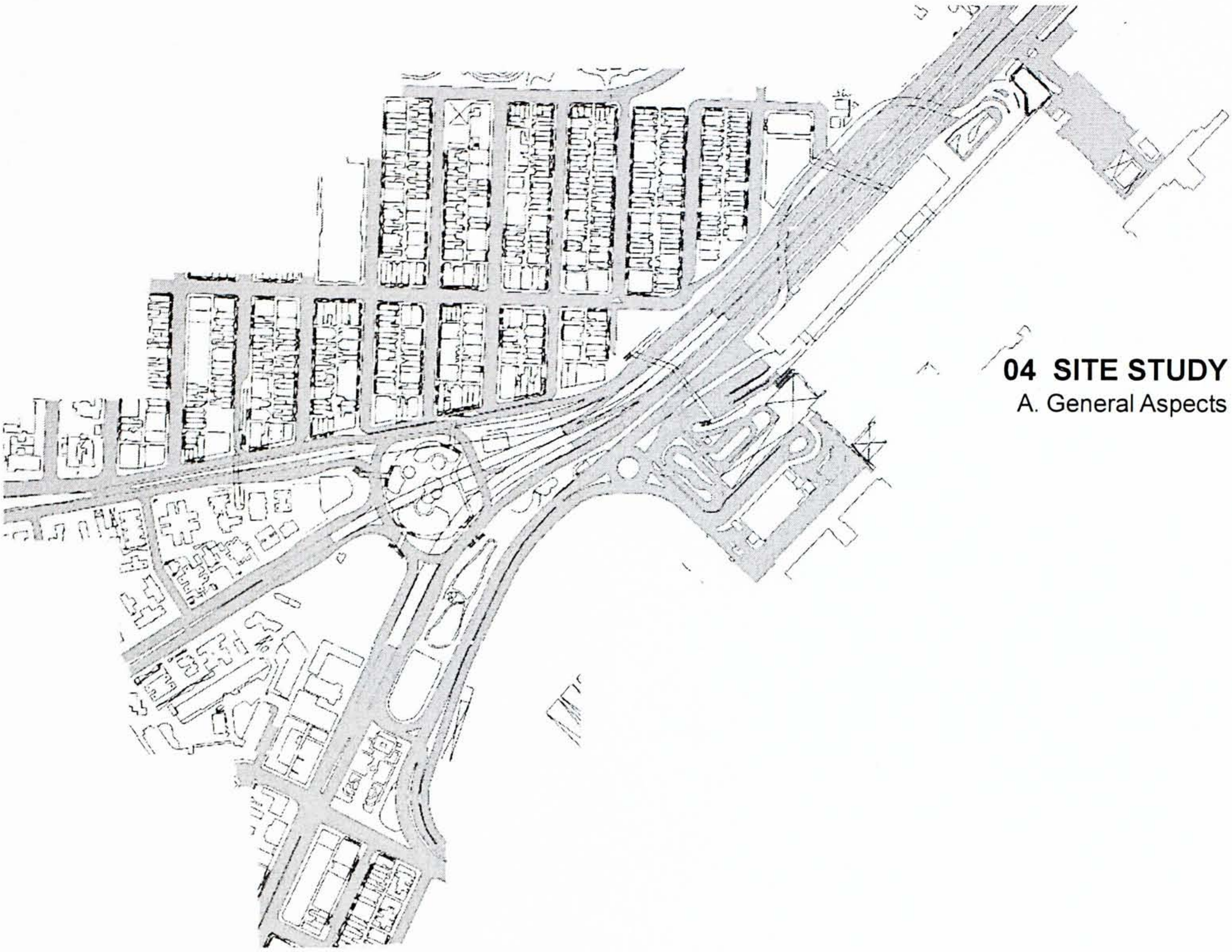



photo a


photo b

04 SITE STUDY
A. General Aspects





04 SITE STUDY
A. General Aspects

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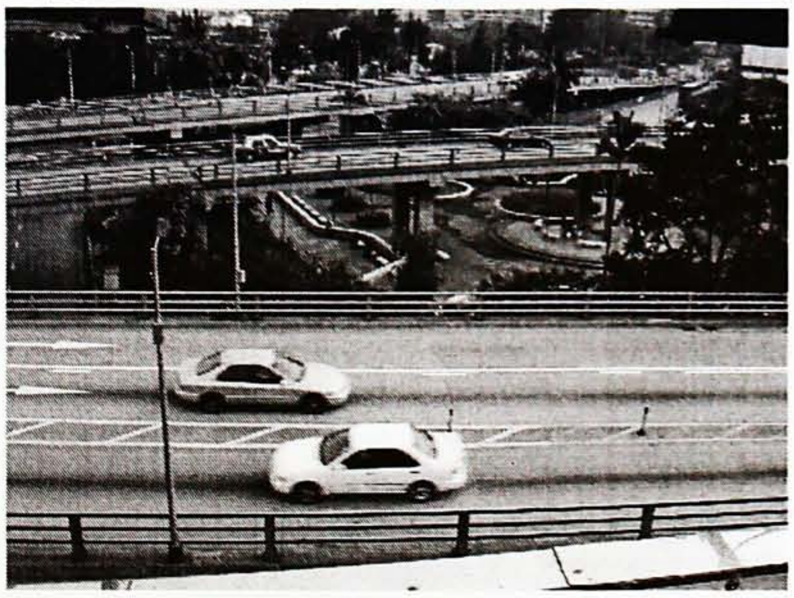
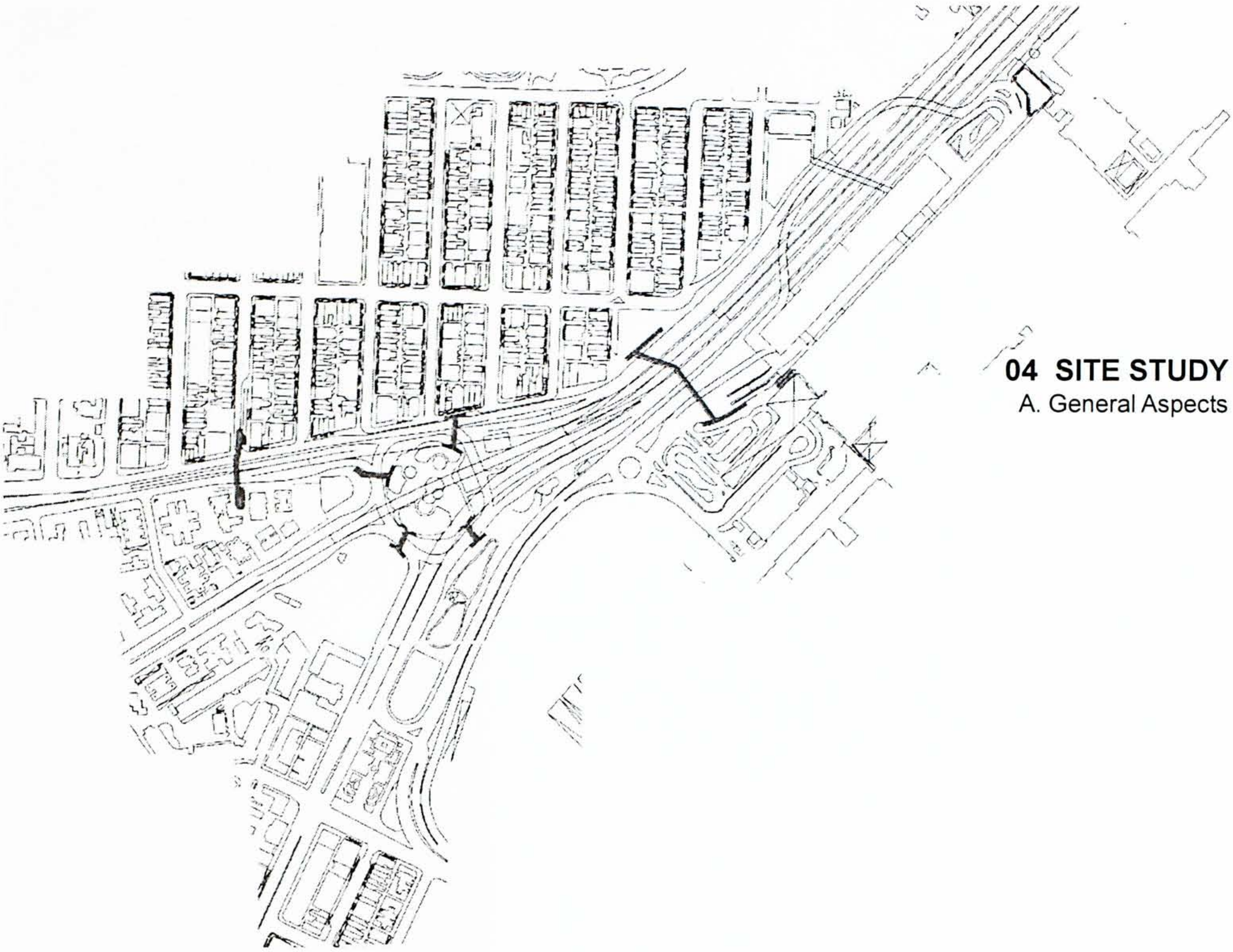
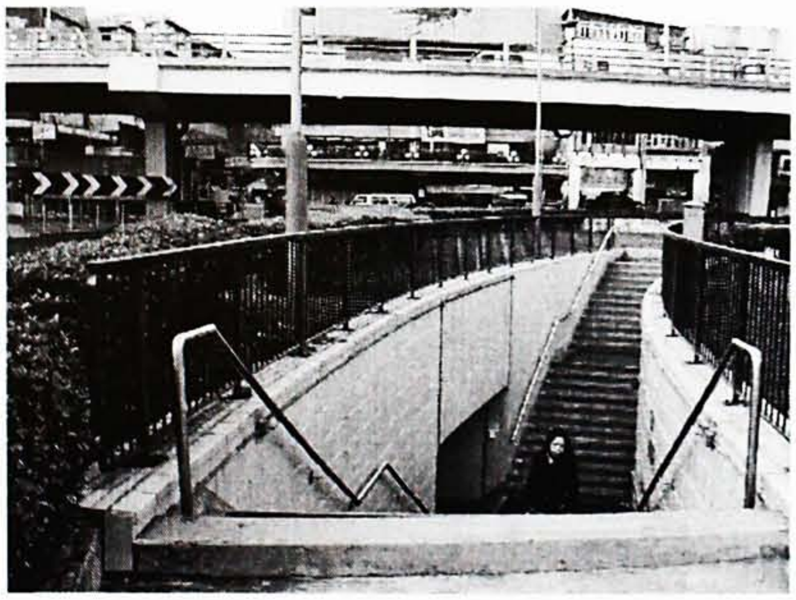
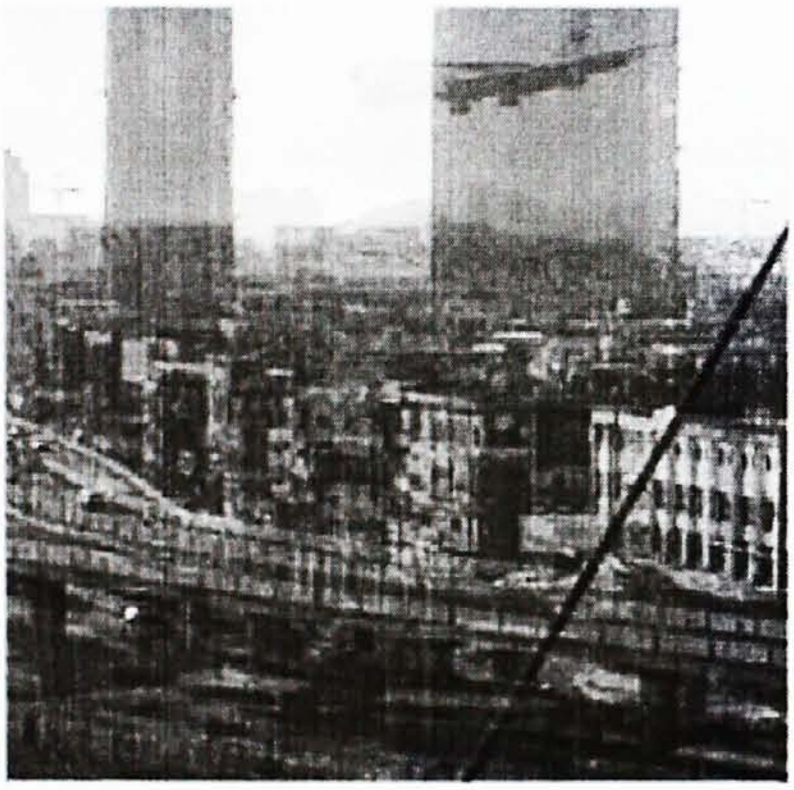




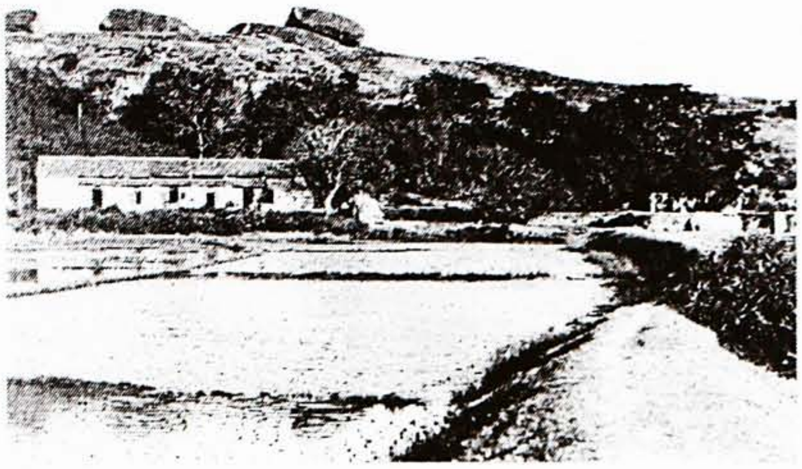
04 SITE STUDY
A. General Aspects





04 SITE STUDY

B. Historical Context

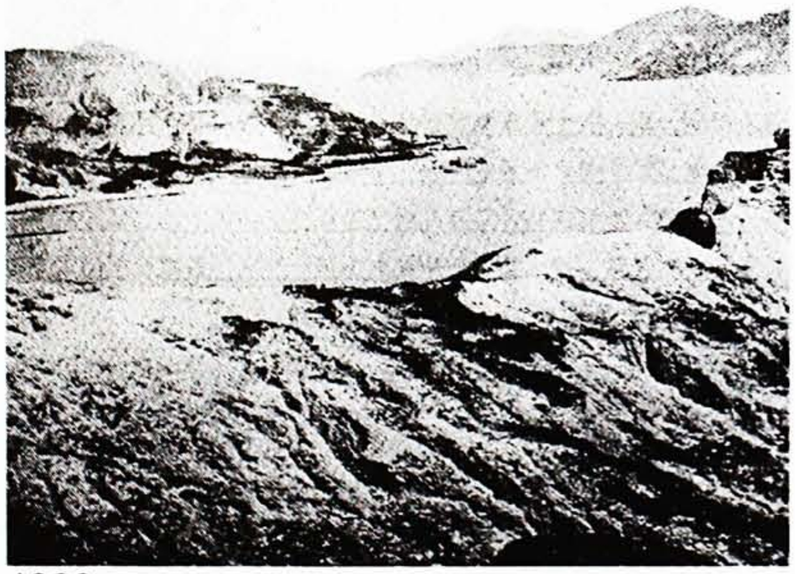


1300

In Sung Dynasty, its last emperor has fled to Hong Kong and left an inscription rock in Kowloon City.

1811

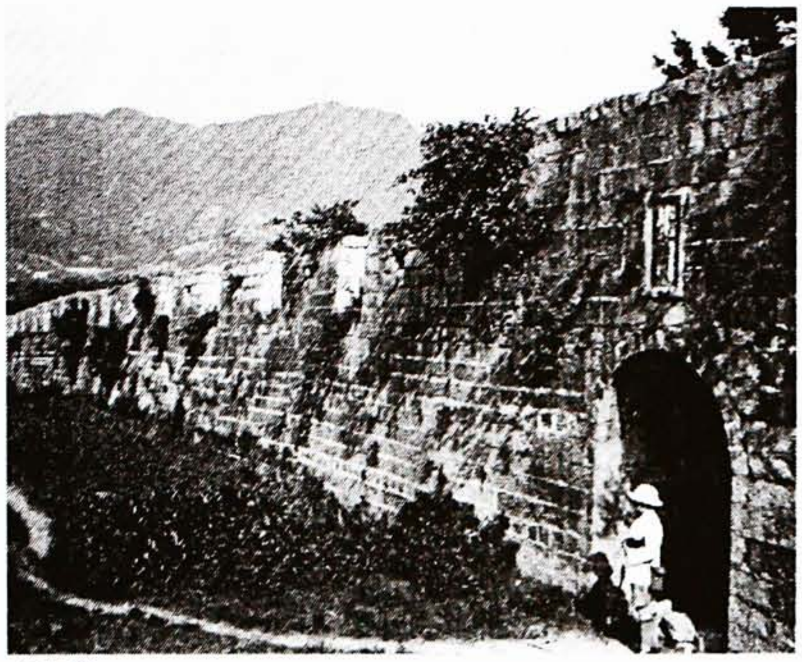
From 19th century, since pirate appeared around Hong Kong seas, Kowloon Fort (now at the location of Kai Tak airport parking building)was built at Kowloon City for defence.



1860

Since 1842, Hong Kong Island was separated from the Qsing Dynasty to British government, Kowloon Walled city was built to accommodate soliders from Qsing Dynasty in order to detect any movement at the opposite side of the harbor.

04 SITE STUDY
B. Historical Context


1899

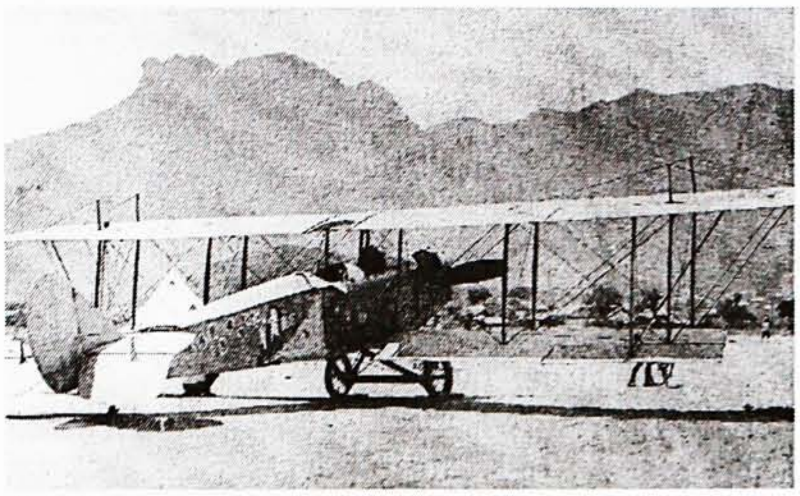
British took over the Kowloon Walled City. Since then, Kowloon Walled City turned to be residential area for Chinese people, though its sovereignty was kept being argued.


1916

Sung Emperor Monument Park was built at its original location.


1919

Mr. Ho Kai and Mr. Au Tak formed a company and applied for a land reclamation project in Kowloon City. Originally, the reclaimed land was proposed for residential use.

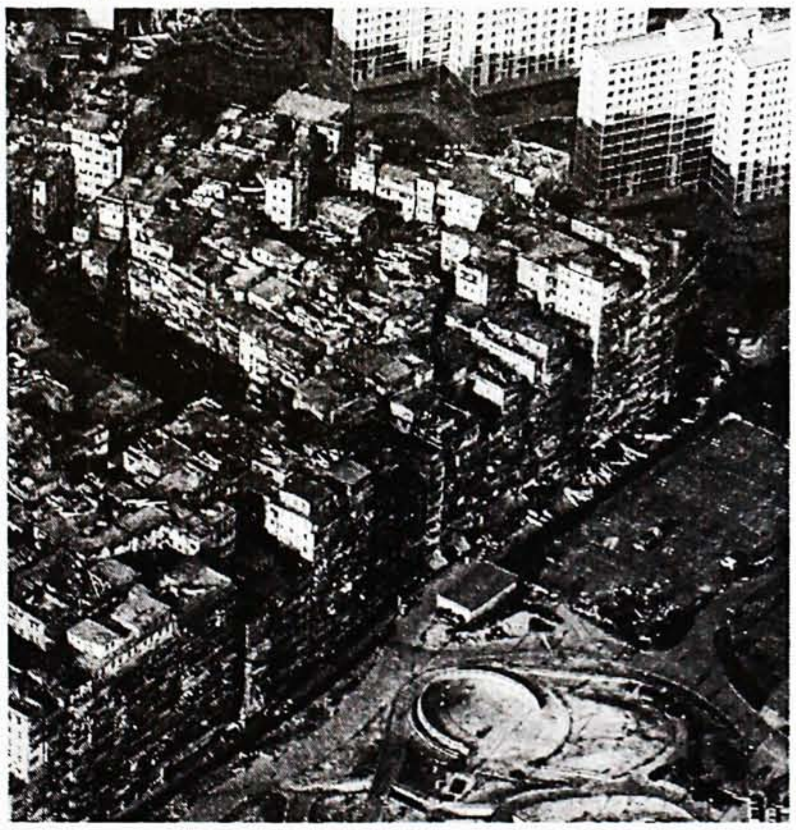


1928

Kai Tak Land Investment Company bankrupted before proposal completion. Hong Kong government turned the land as airport. And Kai Tak airport was first built for military use. In 1936, Kai Tak airport turned to be a commercial airport.

1955

Sung Wong Toi Monument Park was moved to the present location due to the aviation safety of Kai Tak airport. In 1941-1945, Sung Wong Toi inscription rock was destroyed by Japanese troops.



1992

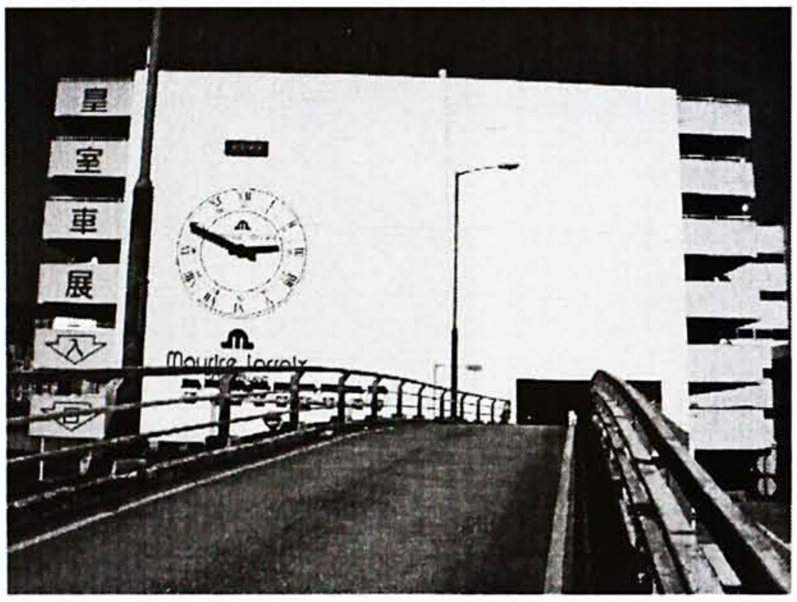
Final clearance of Kowloon Walled City.

04 SITE STUDY

B. Historical Context

1998

Kai Tak international airport was closed and the new airport was moved to Chak Lap Kok.



2001

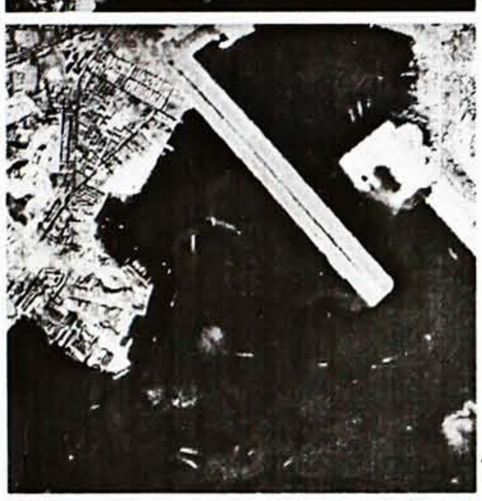
Kai Tak international airport is now turned to entertainment center temporarily.

2002

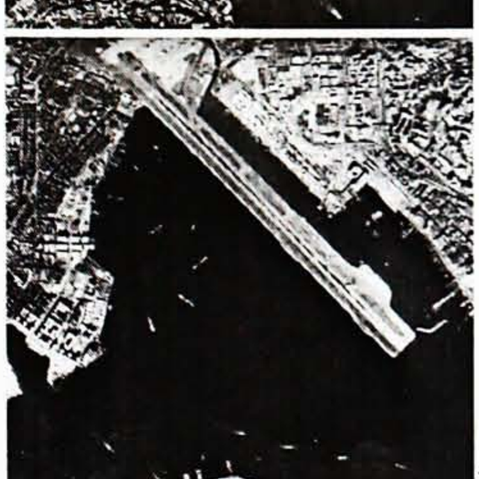
Following with the cancellation of the building height limit restriction, high-rise residential towers are being erected around the site.

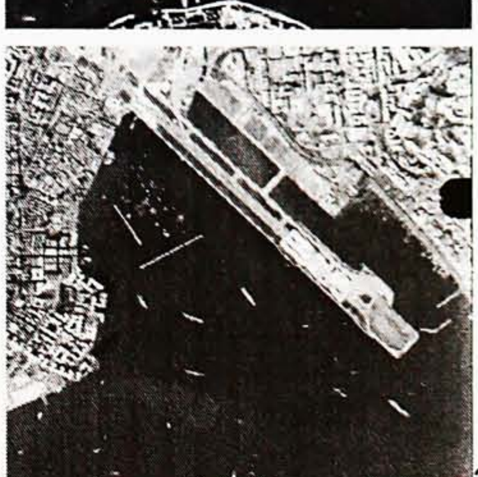

1944


1954

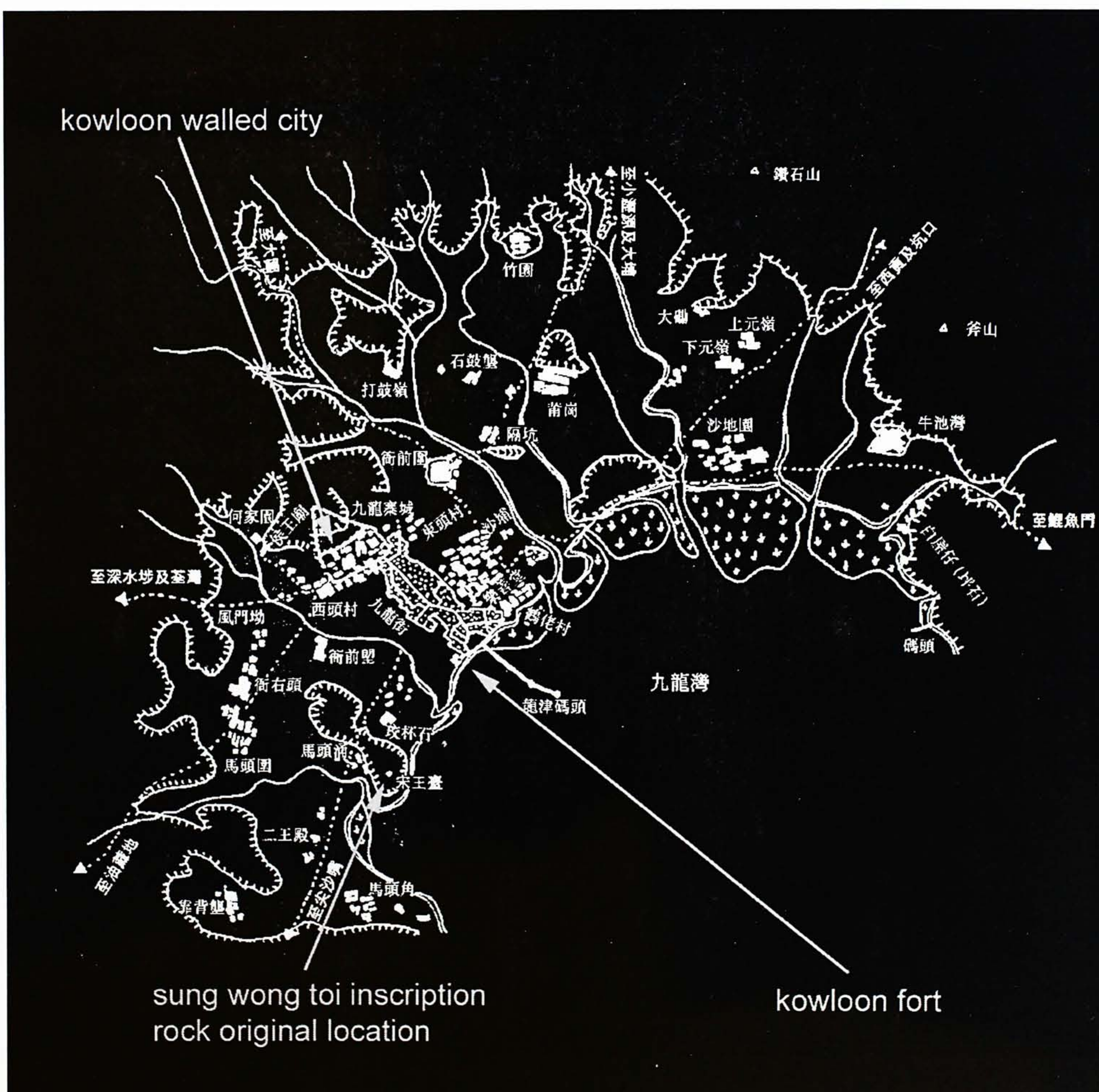

1964


1975


1989


2000

04 SITE STUDY
B. Historical Context


kowloon walled city
sung wong toi inscription rock original location
kowloon fort
九龍灣

04 SITE STUDY
B. Historical Context


N
獅子山景觀
VIEW TO LION ROCK
平台廣場
TERRACE SQUARE
九龍城
KOWLOON CITY
宋皇臺刻石
SUNG WONG TOI INSCRIPTION ROCK
宋皇臺公園
SUNG WONG TOI GARDEN
土瓜灣
TO KWA WAN
BLE FUTURE
DESTRIAN
NNECTION
市中心
TOWN CENTRE
海心公園
HOI SHAM PARK
啟德草坪
KAI TAK GREEN
運動場廣場
STADIUM PLAZA
九龍灣
KOWLOON BAY
運動場
STADIUM
啟德林蔭大道
KAI TAK BOULEVARD
飛鵝山景觀
VIEW TO FEI NGO SHAI
林蔭道
THE AVENUE
都會公園
METROPOLITAN PARK
RUNWAY SQUARE
HARBOUR-SIDE WALK
半圓形街區
THE CRESCENT


獅子山景觀
VIEW TO
LION ROCK
九龍城
KOWLOON CITY
九龍灣
KOWLOON BAY
飛鵝山景觀
VIEW TO
FEI NGO SHAN
土瓜灣
TO KWA WAN

04 SITE STUDY
D. Sound Level Study

04 SITE STUDY
E. Site Condition at Night

04 SITE STUDY
E. Study on Night Atmosphere

05 DESIGN INSPIRATION

A. West Wall
B. The National Vietnam Veterans Memorial
C. Speaking & Listening in Public Space
D. The Desire of Sharing
E. Different Kinds of Marks
F. Different Forms of Memory Storage

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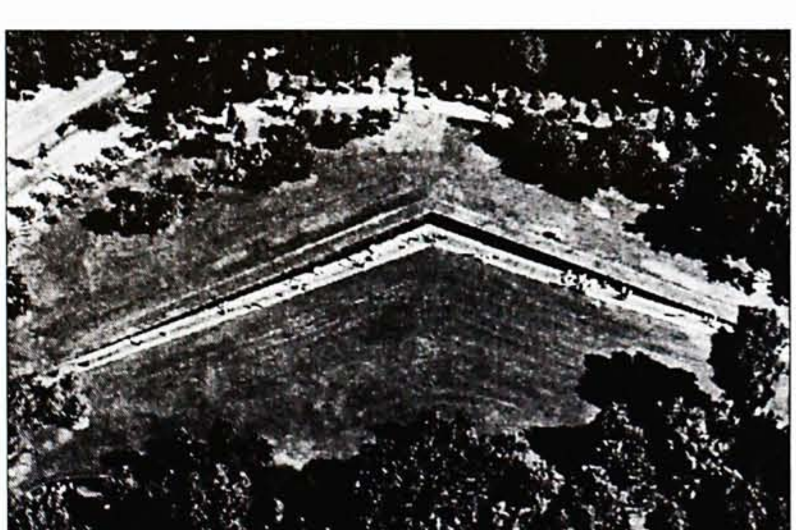
A. West Wall

05 DESIGN INSPIRATION
B. The National Vietnam Veterans Memorial



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C. Speaking & Listening in Public Space

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D. The Desire of Sharing

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E. Different Kinds of Marks

05 DESIGN INSPIRATION

F. Different Forms of Memory Storage

06 DESIGN DEVELOPMENT

A. Prelminary Schematic Design
B. Design Concept Generation

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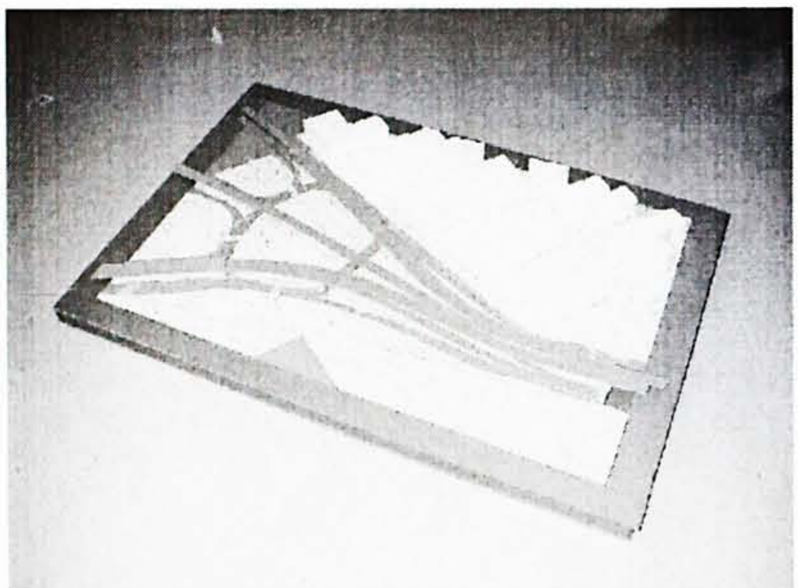
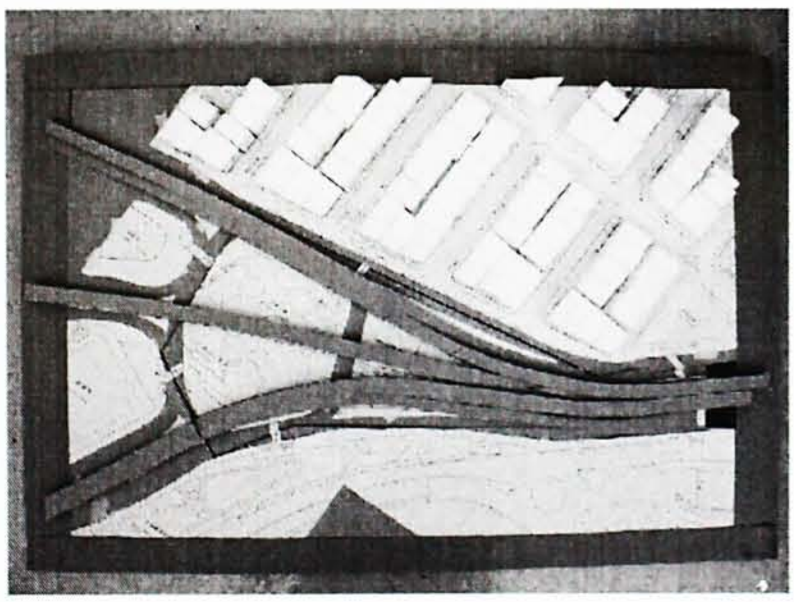
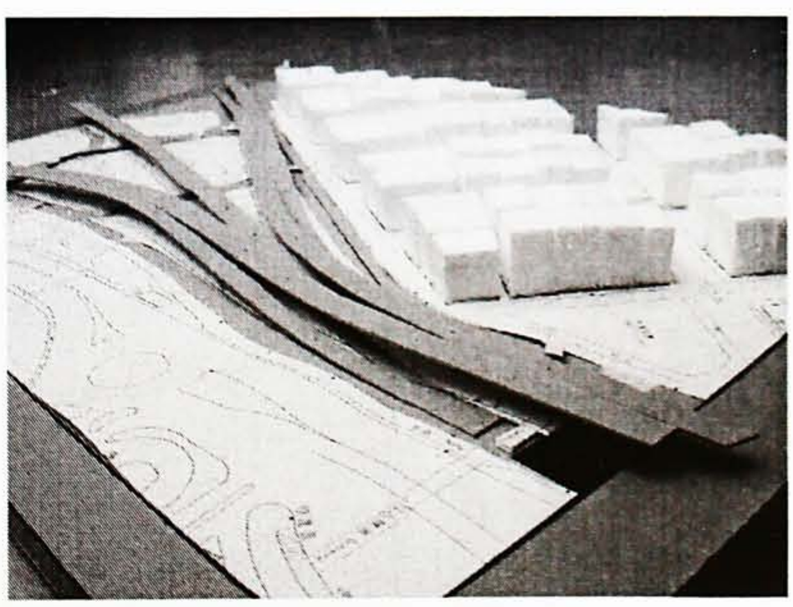
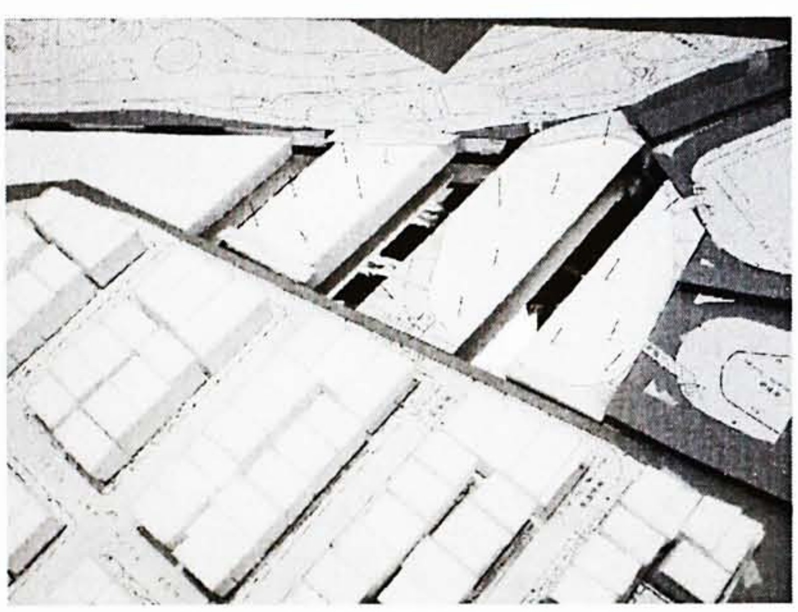
A. Prelminary Schematic Design

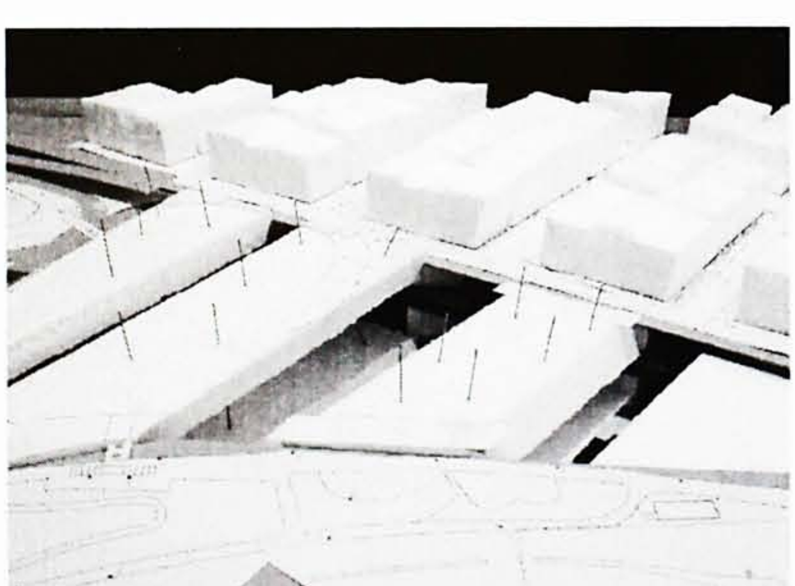






06 DESIGN DEVELOPMENT
A. Prelminary Schematic Design





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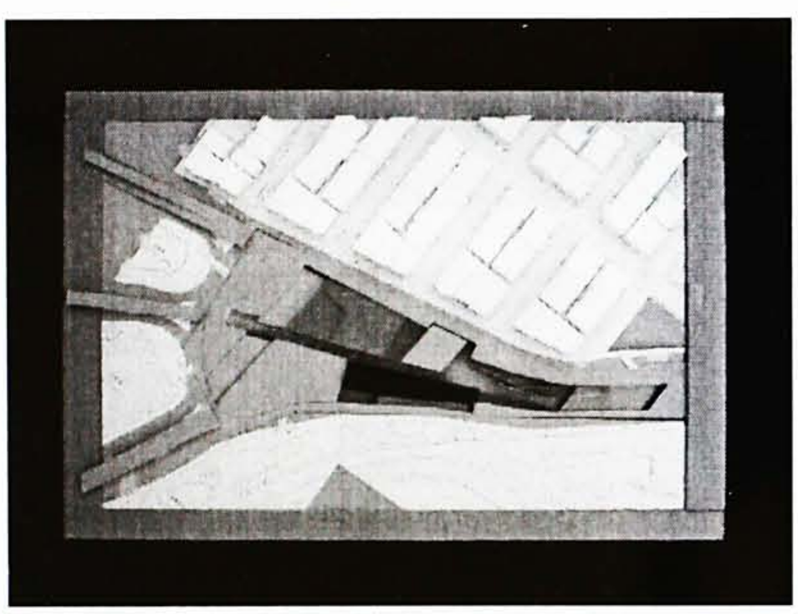

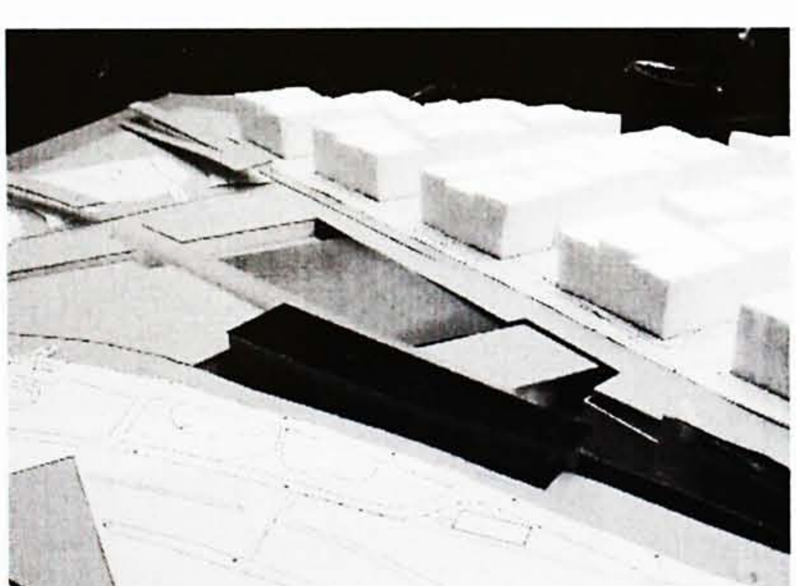

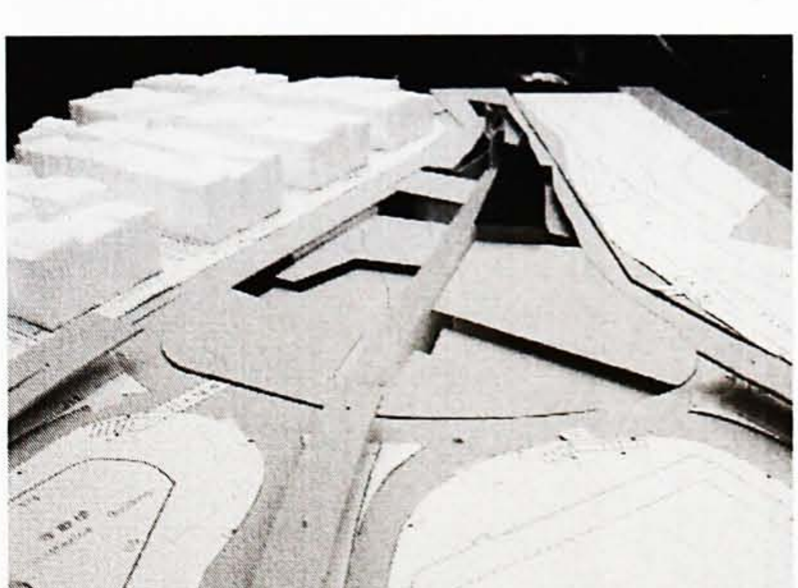

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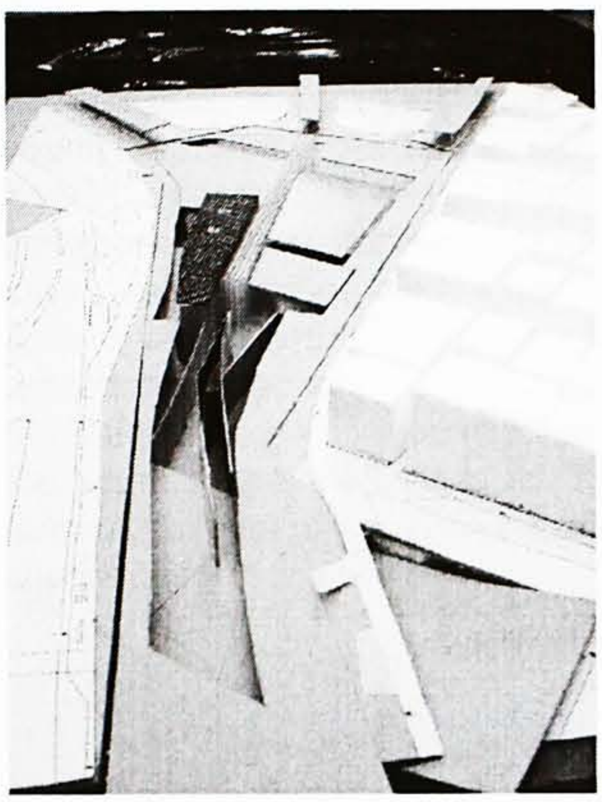
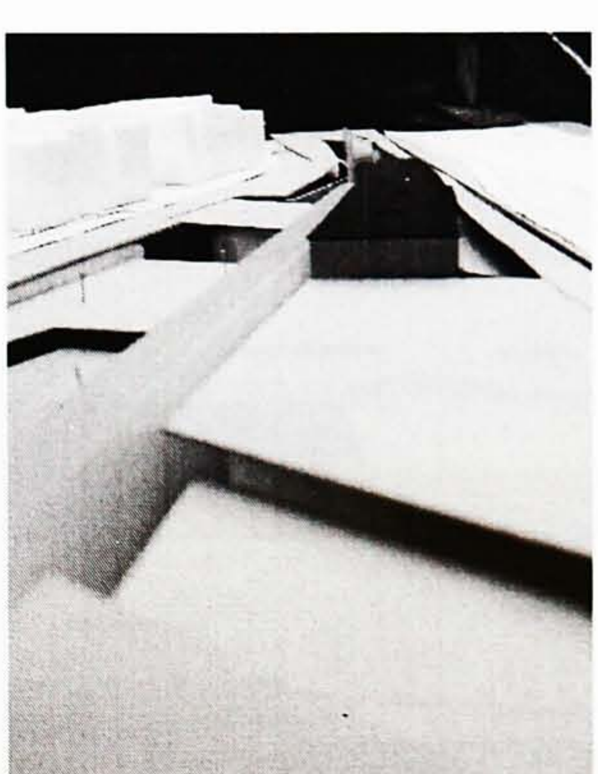
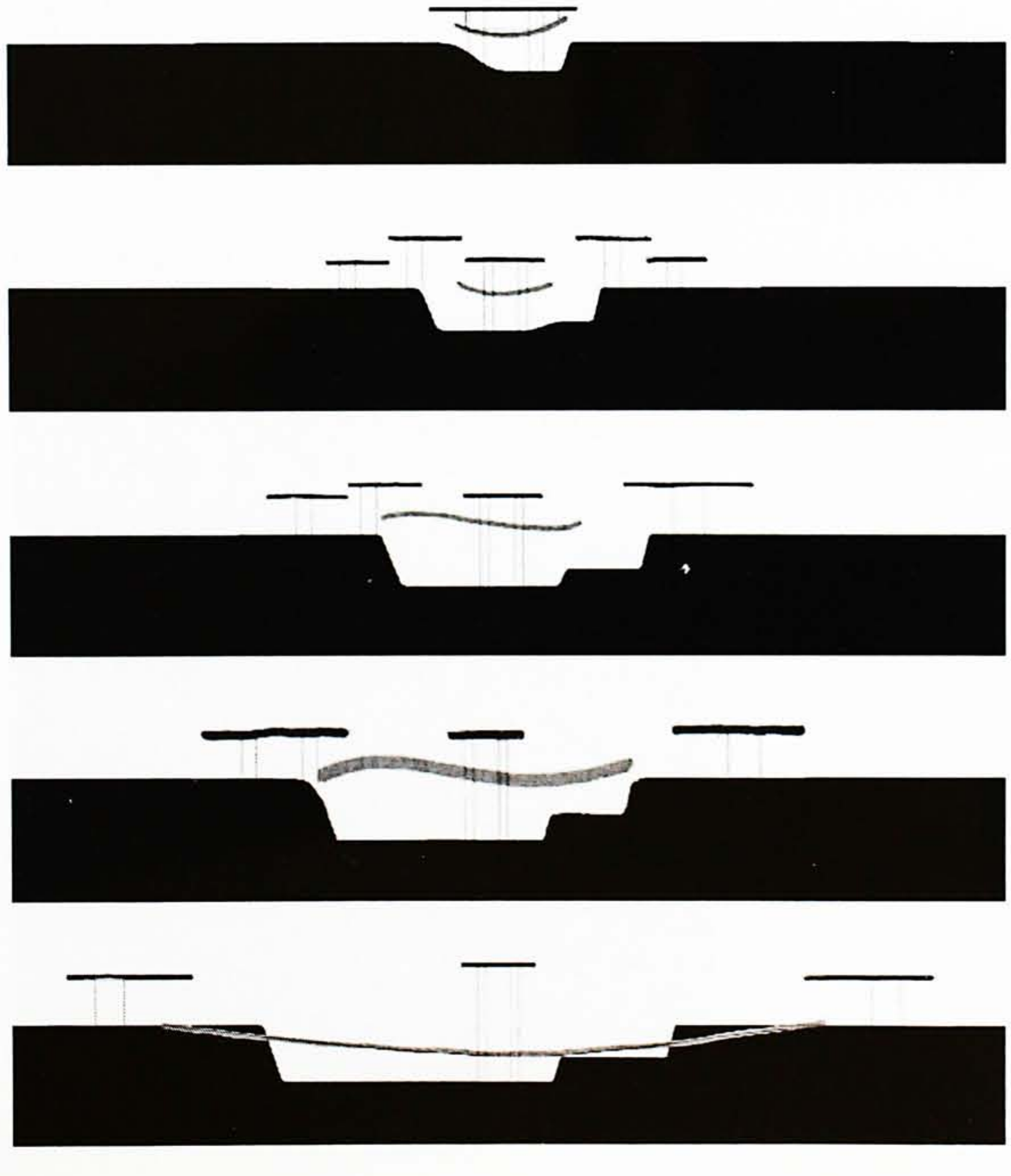




Visualization of the site soundscape

Sound can be sensed by human being, but they are intangible. If sound is the key issue of an architectural design, then the form of the architecture should reflect the existence of sound. Due to the heavy traffic around the site, the soundscape at the site is dynamic and fluctuating. Therefore, the form of the building will reflect a freezed moment of the soundscape at the site. By the sound pressure level study at the site, a logic is derived from it: the more dense the traffic roads come together, the higher sound pressure will be.
Sound would react on any surfaces, e.g. reflection, refraction, interference and echo. Guilding surface can also react and reflect to the soundscape it exposed to. The building form of this design would be depended on the soundscape of the site.

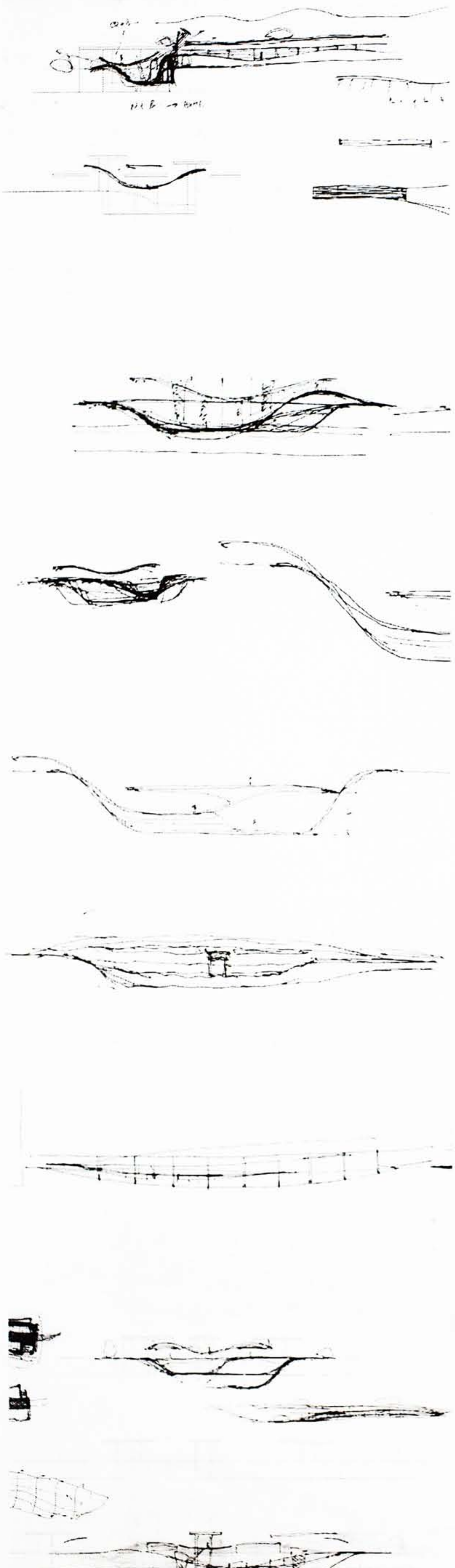
06 DESIGN DEVELOPMENT
B. Design Concept Generation



Co-laboration between Audio Sequence & Spatial Sequence

Along the main axis of the site, a sequence of different acoustic experience would inter-relate to the spatial experience sequence. How the two secquence merge together would generate a new perspective of our usual sensation to a building. For example, a dark space need not to be silence. or a scene of heavy traffic may not imply noisy environment. Such kind of unusual disconnection between different sensations may bring out a new perspective and challenge towards traditional norm of building design consideration.

06 DESIGN DEVELOPMENT
B. Design Concept Generation



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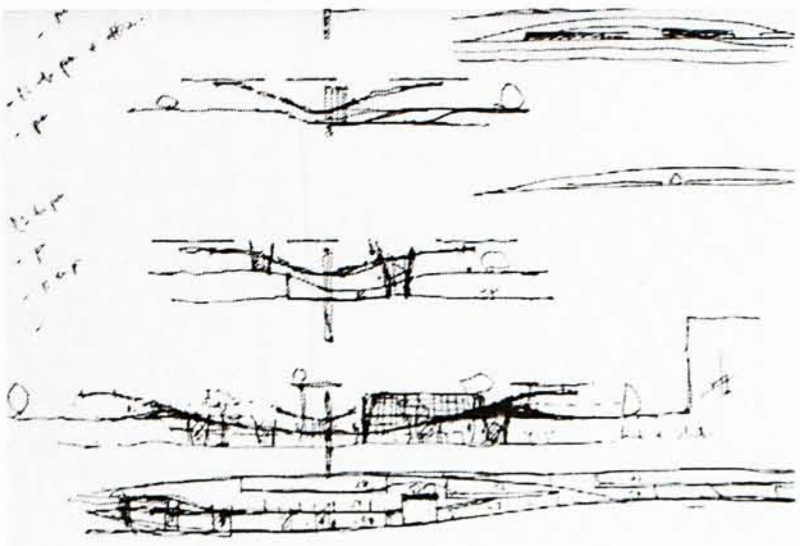

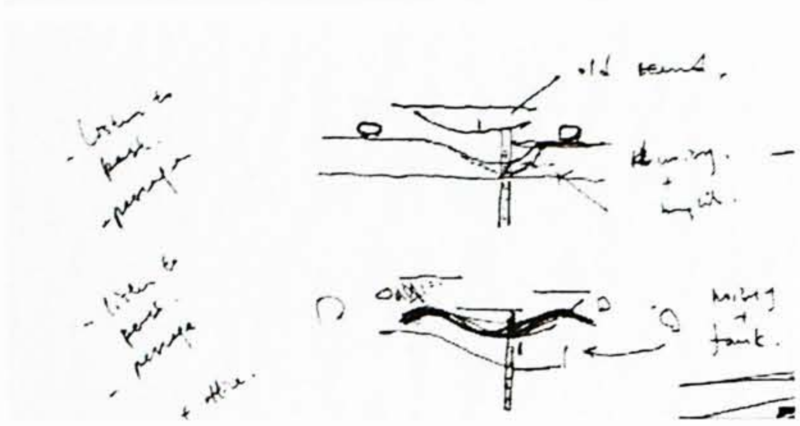

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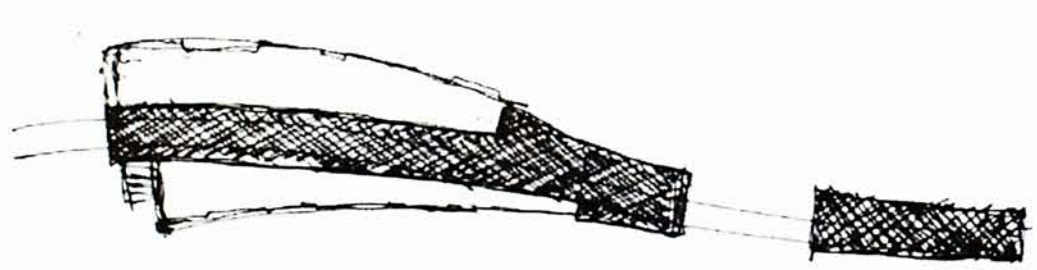

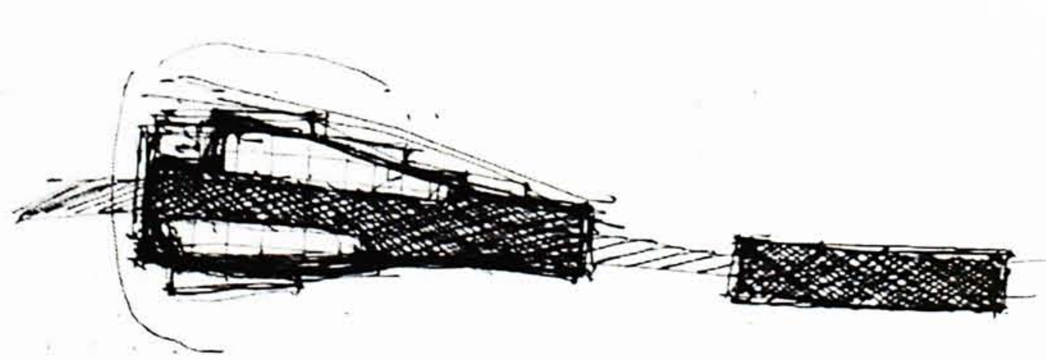

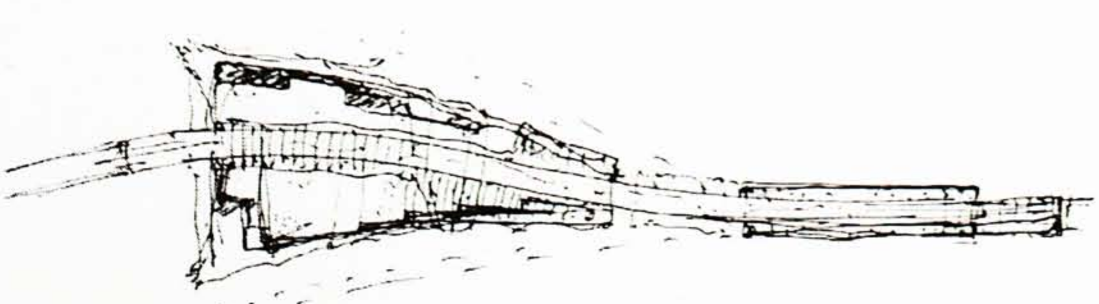

07 FINAL DESIGN

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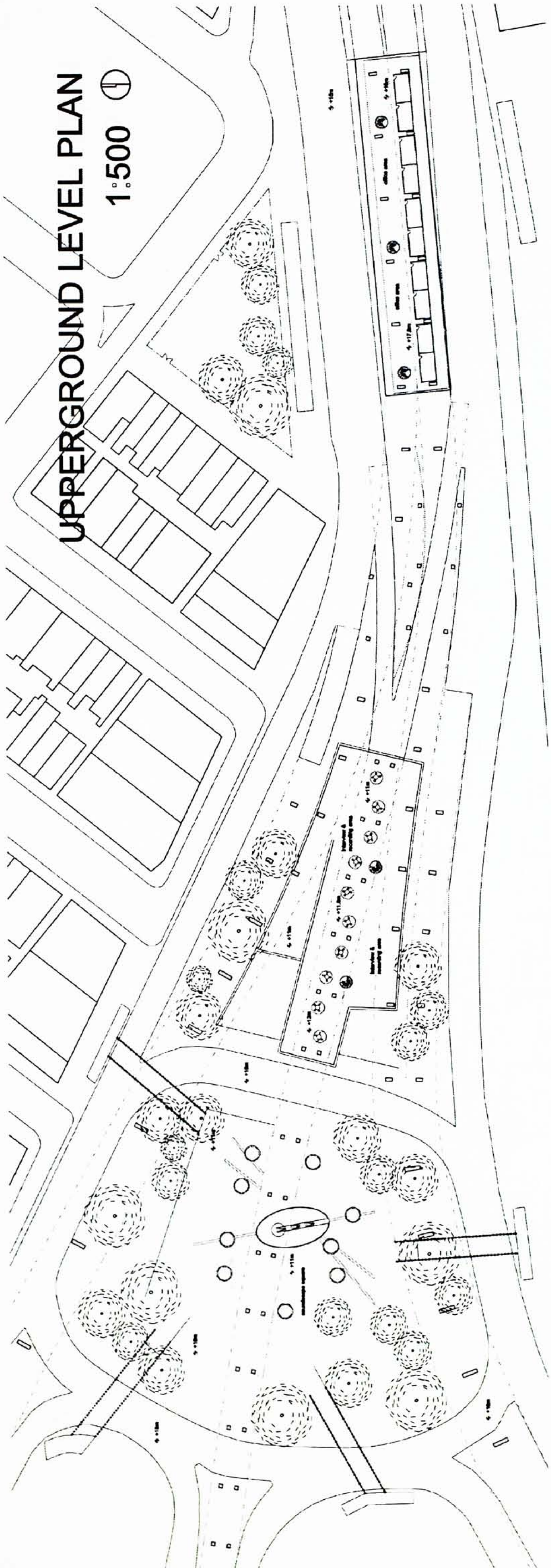
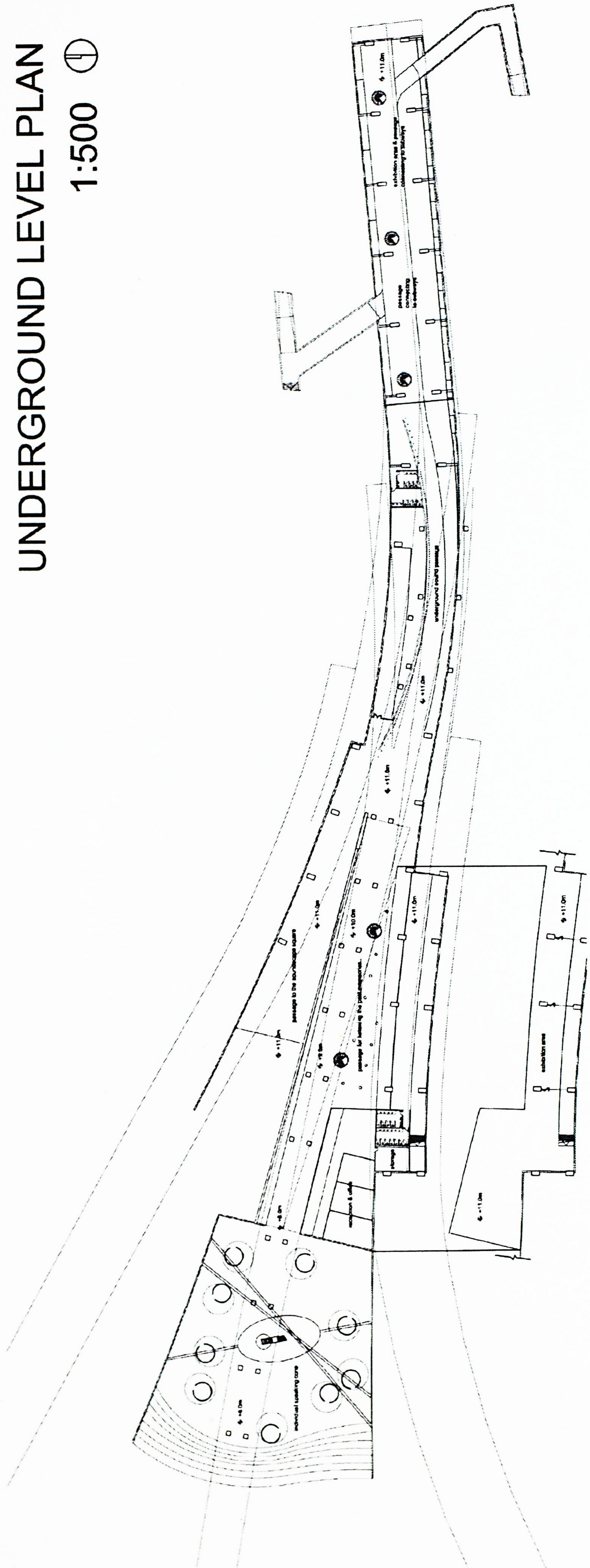


07 FINAL DESIGN

UNDERGROUND LEVEL PLAN
1:500



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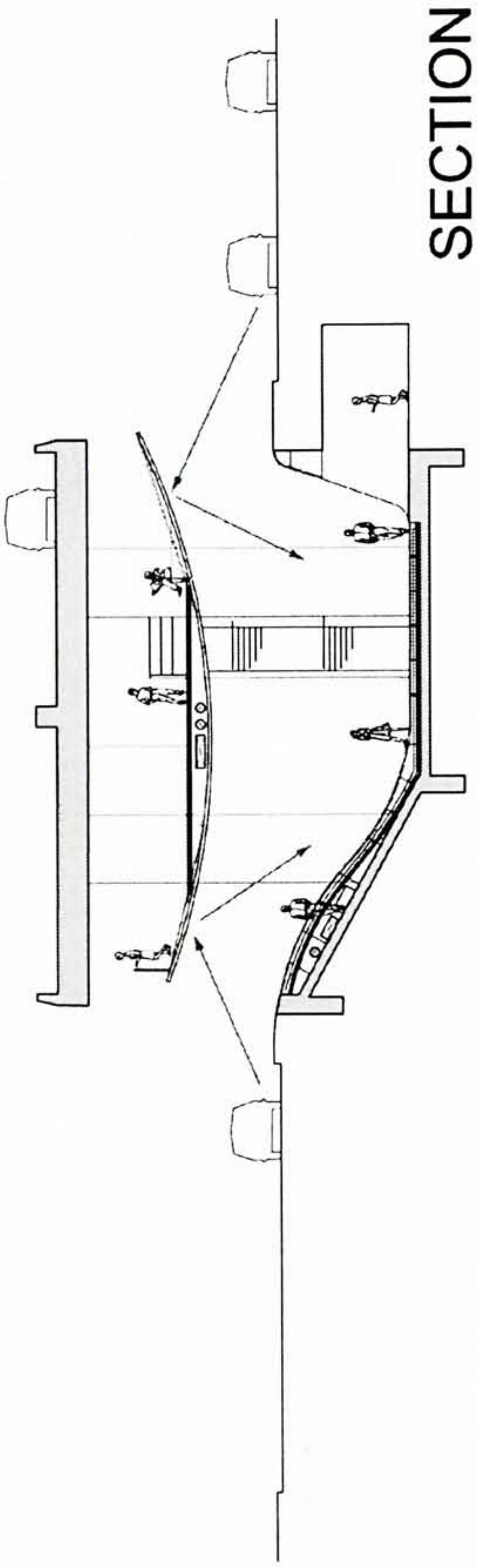
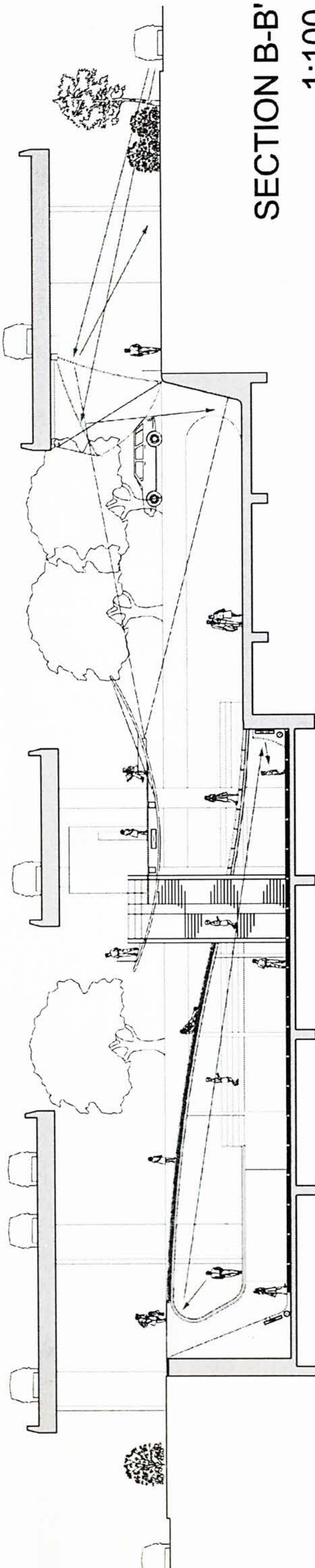


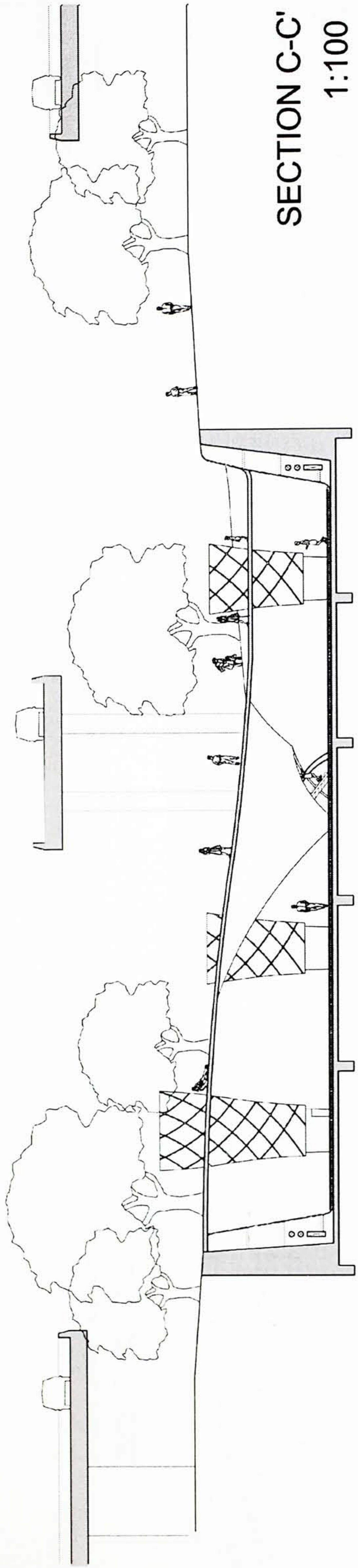
SECTION A-A'
1:100

07 FINAL DESIGN



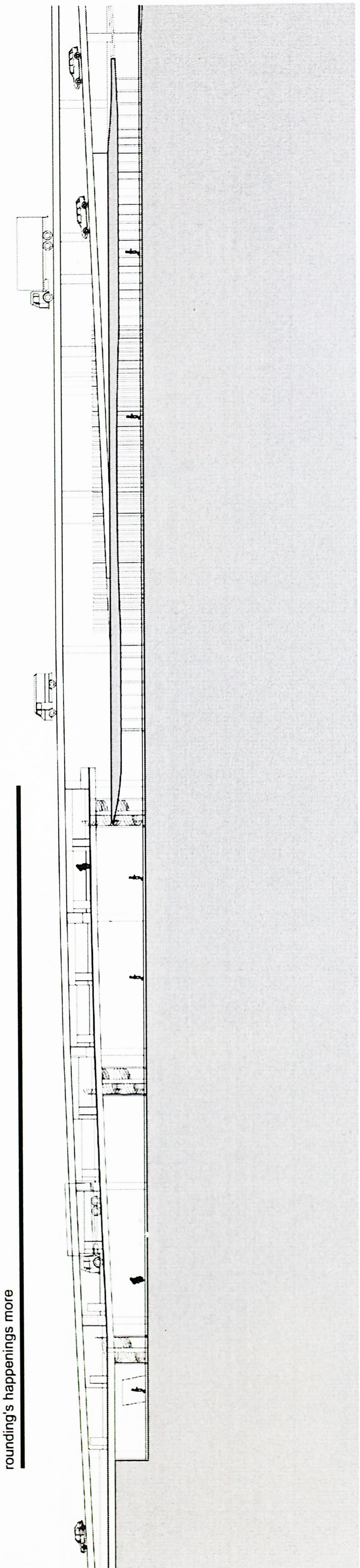
SECTION B-B'
1:100

07 FINAL DESIGN



SECTION C-C'
1:100

07 FINAL DESIGN



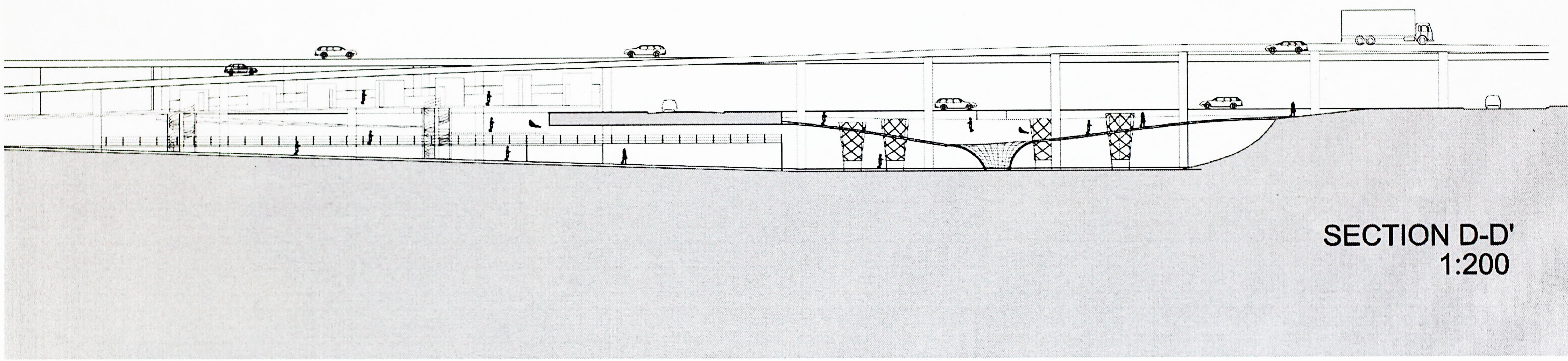
Acoustic sequence 1: bright and noisy - people would aware of their environment and focus on the surrounding's happenings more

Acoustic sequence 2: dark and noisy - the space gradually turned dark and the traffic sound above the ground is transmitted by a series of copper tube down to the under-ground. Without the presence of sufficient light, the sensation of sound come out.

Acoustic
played b

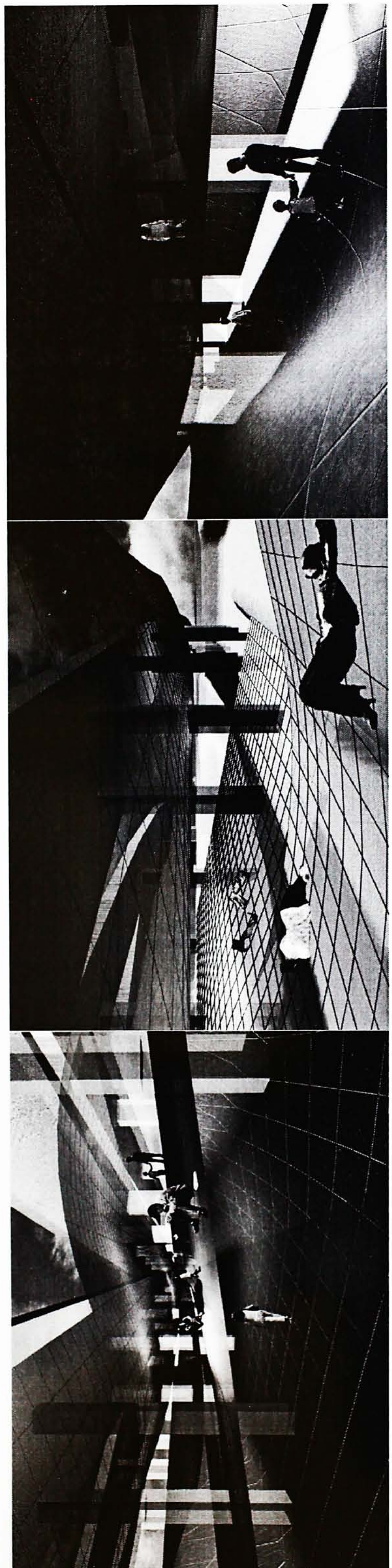
: sequence 3: noisy environment is isolated from the space, and records of people voices are ›ack in the speakers hidden in the columns of the space.

Acoustic sequence 4: a dark and silent zone is the final distinction of the settings, where people's sensations of sound and light are deprived and by then their awareness of ownself come out. At this atmosphere and mood, people can be concentrate on their own stories and leave their memories recorded there.



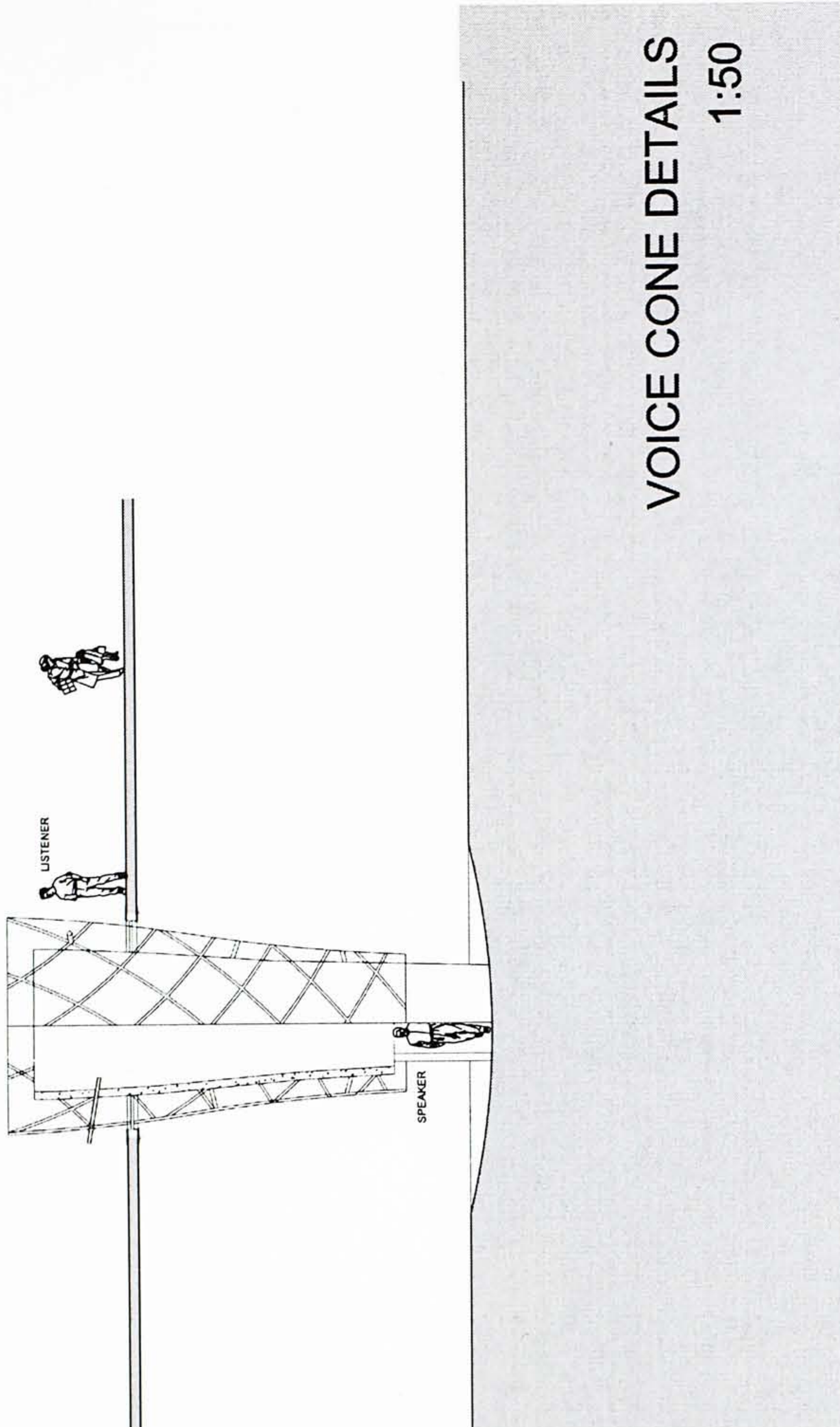
SECTION D-D'
1:200

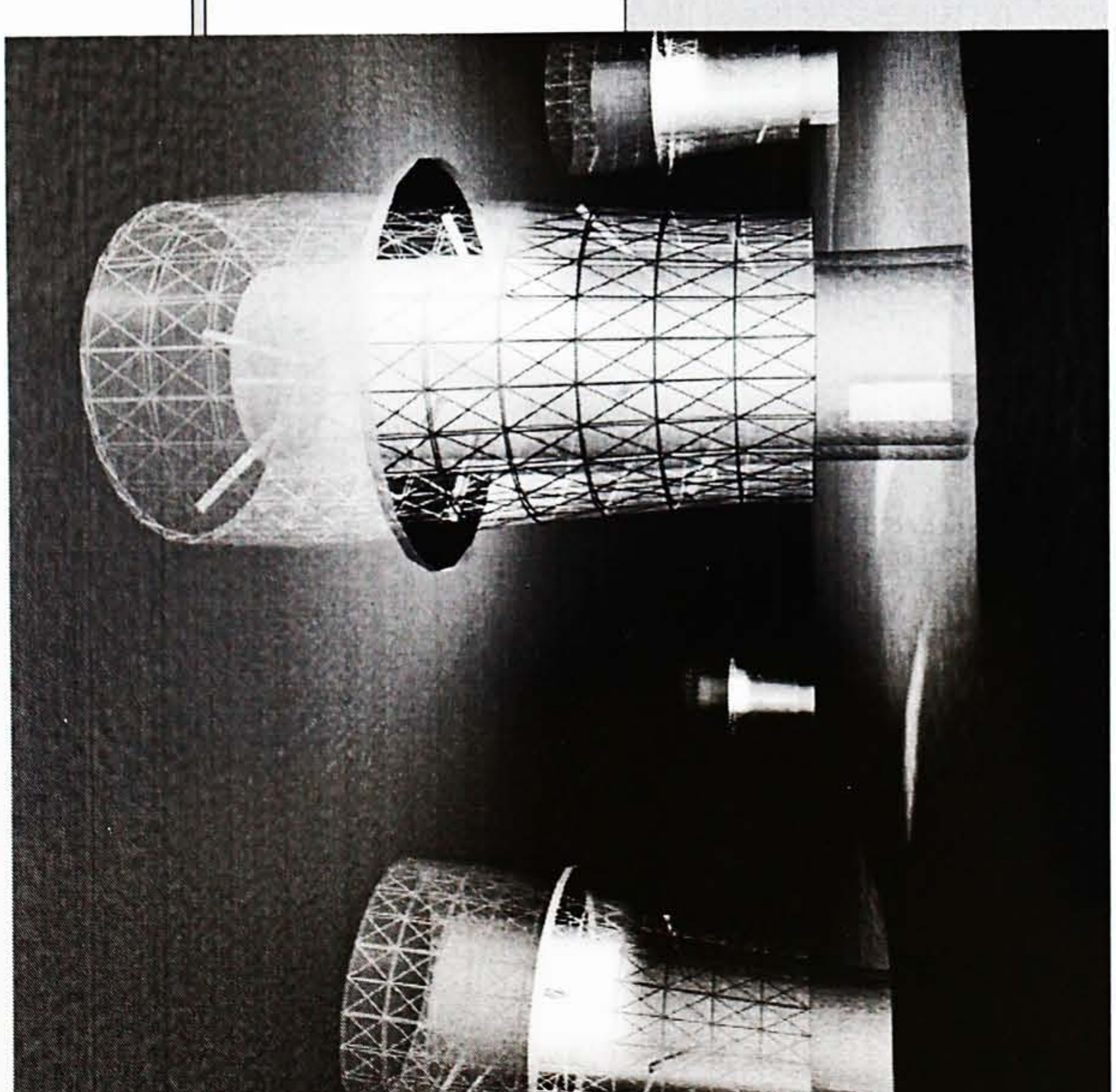
07 FINAL DESIGN



07 FINAL DESIGN

08 SPECIAL STUDY
Voice Cone





08 SPECIAL STUDY
Voice Cone

09 APPENDICES

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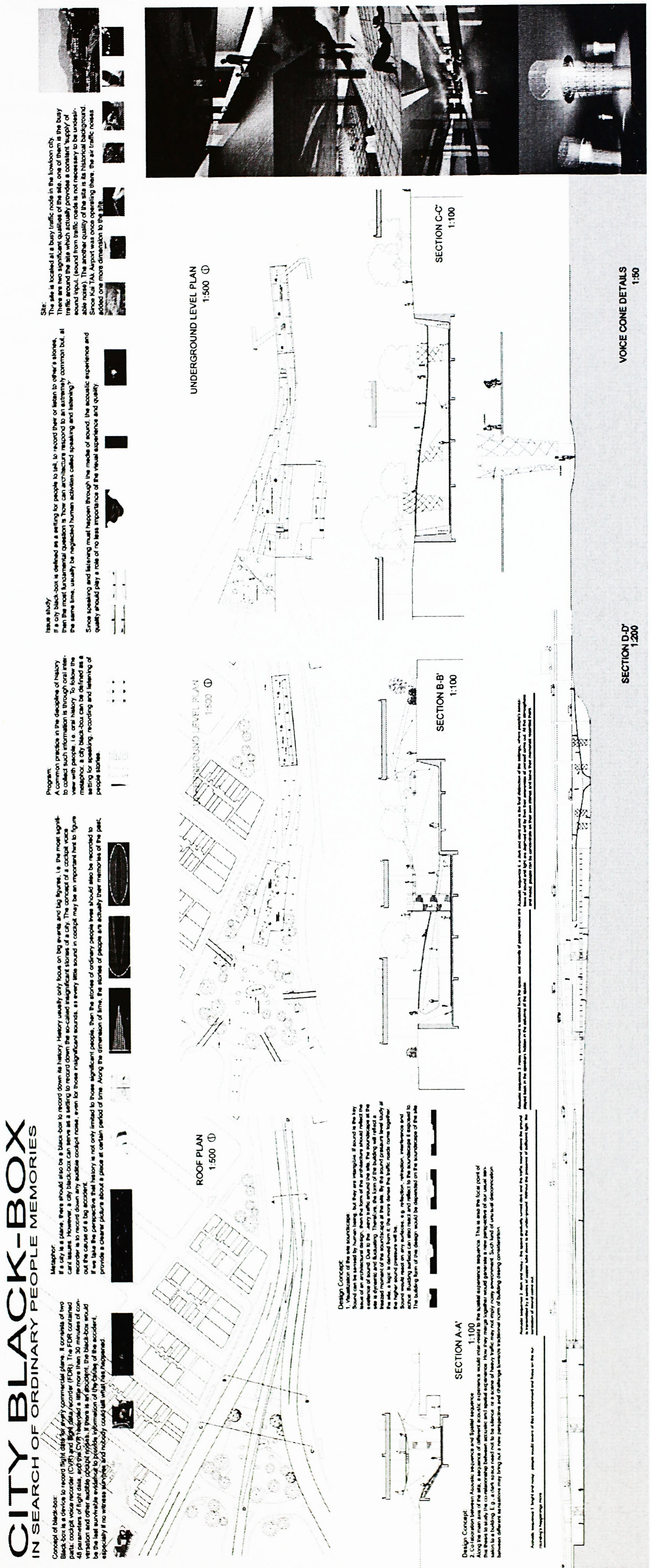

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